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LOCAL IMMUNIZATION OF TISSUES OF THE NOSE, THROAT AND EAR BY BACTERIAL VACCINES *

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The application of vaccines locally in the treatment of diseases of the nose, throat and ear, should appeal to the otolaryngologist. It has been our experience that vaccines applied hypodermically, whether they have been autogenous vaccines or heterogenous combinations manufactured by a commercial concern, have not met with the desired success. It has always seemed to me that, in our special field, it was often a question of luck whenever the result we were looking for was attained.

It was only during the past summer that my attention was called to the amazing results attained by Professor Besredka,[1] of the Pasteur Institute of Paris, in the prevention of typhoid fever by the local administration of typhoid vaccine. It would be beyond the scope of this paper to go into details. Like all great discoveries, Professor Besredka came on this one by accident. He had been experimenting with some rats in the laboratory, and had been feeding some of these rats with killed typhoid germs. One day, he desired to inject a rat with some live typhoid bacilli. Not having a rat that had not been experimented on, he picked out one that had been fed some of the killed typhoid germs. He was astonished when he discovered that this rat withstood a hypodermic injection of live typhoid bacilli which would kill an ordinary rat. He started a series of experiments until he had proved to himself (1) that the experiment was harmless, and (2) that such an experiment could be performed in man without any harmful results. From that time on, he had many opportunities to use his vaccine in numerous epidemics of typhoid and dysentery, when the people refused to have the usual inoculation. The results were not only just as good in the prevention of typhoid fever but often better. Later experiments proved that vaccines could be prepared for other conditions. For example, it has been proved that

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1. Besredka, A.: Local Vaccination, Paris méd. **12**:496 (Dec. 2) 1923.

the entire skin area of the body is one organ, and that if a part of the skin is immunized directly, such as in acne or in furunculosis, the whole will be immunized. A broth vaccine can be prepared and applied as a poultice in certain skin conditions with astonishingly good results. Then, again, it was found that bone infections (osteomyelitis) responded very well to such treatment. A broth culture is made of the infecting organisms, and the entire wound is poulticed with the vaccine. The reports in such cases are more than satisfactory. I myself have proved its value in wound infections by applying such vaccine to slowly healing mastoid wounds, when the restorative power of the patient seemed to be below par.

The vaccine administered for the prevention of typhoid fever is simply a tablet of desiccated, killed typhoid bacilli. In order to hasten and increase the action, the patient is given a tablet of shellac-coated bile a half hour before the bacilli are ingested. When the vaccine is given for other conditions (such as wound infections), a broth culture is made of the predominating bacteria, which is applied locally as a wet dressing. Whether it is better to use the dry, killed bacteria or the broth culture in nose, throat and ear conditions remains to be seen. Up to the present time I have used only the broth culture, but I have discussed the possibility of using the killed bacteria alone and will attempt some experiments along that line in the near future. For practical purposes, the broth vaccine is satisfactory.

METHOD OF PREPARING THE VACCINE

A culture is made on a sterile swab and immediately sent to the laboratory. Swabs which are not taken care of at once will dry out, so that an impaired growth or no growth at all will result. A culture taken from the ear canal, from a wound or from the throat is a simple matter, but cultures taken from the nose will be valueless unless taken directly from the pus or from the posterior regions of the nose. Cultures taken from the anterior portion of the nose are usually sterile, a definite indication that the mucus secreted by the nasal mucosa has an antiseptic action.

As soon as the swab reaches the laboratory, it should be immersed in the culture medium. Dr. Winslow, in whose laboratory this work was done, gives the following instructions:

Technic of Sterile Mass Broth Cultures.—One should prepare a 1 per cent. glucose meat extract or meat infusion broth. Because of the large amount of sugar, one should be careful to have it as near neutral as possible and also see that it is clear. We clear it in animal charcoal rather than egg, because the phosphates from the eggs are liable to precipitate out in such a neutral solution. One should keep the broth in 50 c.c. centrifuge tubes with small mouths, plugged with nonabsorbent cotton. They should be filled only three-quarters full, for if they are completely filled, they will boil over when sterilized. They are then

sterilized in the autoclave for ten minutes at 12 pounds pressure. They can then be stored away ready for use.

Two centrifuge tubes are inoculated for each case by dipping the swab directly into the broth. The tubes are incubated for forty-eight hours; at the end of that time, there will generally be a heavy growth. The sediment is then shaken up, and the contents of both tubes are poured into a sterile 4 ounce bottle with a plain, sterile cork. Four drops of tricresol are added as a preservative, and also a small amount of sterile saline solution to fill the bottle. The cork should be tied on with a string, and the bottle completely immersed in a water bath at 60 C. for one hour. This generally proves sufficient to sterilize it. If the cork is not tied fast, it will blow out in the water bath. After the bottle has cooled, it is labeled and ready for use.

The reason for sterilizing the broth in centrifuge tubes is that sometimes a type of bacteria is present which causes too bad an odor to allow spraying into the patient's nose. This odor is generally due to the proteus bacillus. In such cases, the tubes can be centrifuged, the broth discarded and a saline suspension made.

Often a pure mucus discharge from the nose is so naturally antiseptic that it is impossible to start a growth in the broth. In such cases, it is best to take a culture from the posterior nares or nasopharynx.

In certain cases, as Dr. Winslow stated, we found it advisable to centrifuge the broth culture and make a salt solution suspension of the bacteria. A number of interesting questions arose. Would the salt solution suspension prove as efficacious as the broth culture? If it is not as valuable, is it possible that a bacteriophage can develop in the broth culture which helps in the curative process? An observation was made in the early days of this work, which is worthy of mention. Dr. Winslow found that the height of the growth in the broth medium was reached at the end of forty-eight hours. After that time, not only was there no further growth but there was a tendency on the part of the bacteria to die. It was then determined to find out whether this inoculated broth could again be inoculated. The broth was sterilized, so that all bacteria of the first growth were killed, and was then reinoculated. It was impossible to obtain any growth. It was decided that one of two things had happened—either the nutrient properties of the broth had been destroyed or else an actual bacteriophage had developed. I cannot enter on a discussion of bacteriophage at present, but there is no question that certain ultramicrobes have the power to destroy bacteria. It perhaps is also possible that such a destruction induces certain chemical changes in solid or fluid mediums. These are points for the bacteriologist to determine. If definite bacteriophagic properties develop in the vaccine, it is but an added reason for its use.

The cultures were invariably placed in broth. At first, there was no attempt made to determine the types of bacteria because mass vaccines were to be prepared, and therefore it made little difference. But after a short time it was felt that, for scientific purposes at least, it was advisable to plate out the organisms. It was soon found that there were numerous types of bacteria which fell into various groups, the most important of

which were the streptococci and the staphylococci. It would have been far more interesting if we were not forced to name one type of streptococcus as predominating, but in all of these cultures the long chain streptococcus overgrew all other types. Again, one realizes that there are various kinds of bacteria that will grow only in blood mediums which were not used in these experiments. In future work along this line, this may be attempted.

In a preliminary communication on this topic, published in the *New York Medical Journal,* Feb. 18, 1925, I reported the results of the use of 138 out of over 200 vaccines made. Since that time, nearly 200 more vaccines have been made, but for the purposes of this paper, I am basing my statistics on the first 200 cases.

TABLE 1.—*Findings in Two Hundred Cases*

Staphylococcus aureus	18
Staphylococcus aureus and Micrococcus catarrhalis	17
Staphylococcus aureus and Streptococcus communis	25
Staphylococcus aureus and Friedlander bacillus	2
Staphylococcus aureus and gram-negative bacillus	1
Streptococcus communis	35
Streptococcus communis and Micrococcus catarrhalis	27
Streptococcus communis and gram-negative bacillus	6
Streptococcus communis and Micrococcus crassus	1
Pneumococcus	14
Pneumococcus and Staphylococcus aureus	1
Pneumococcus and Micrococcus crassus	2
Pneumococcus and Micrococcus tetragenous	1
Pneumococcus and streptococcus	2
Pneumococcus and gram-positive bacillus	1
Pneumococcus and Micrococcus catarrhalis	4
Micrococcus catarrhalis	14
Micrococcus catarrhalis and gram-negative bacillus	7
Micrococcus crassus	10
Micrococcus tetragenous	2
Pneumococcus and gram-negative bacillus	2
Diphtheroid and gram-negative bacillus	1
Friedlander bacillus	1
Micrococcus tetragenous and streptococcus	1
Micrococcus catarrhalis and Micrococcus crassus	3
Micrococcus tetragenous and large diphtheroid	1
Micrococcus tetragenous and catarrhalis	1

In these cases, fourteen different types of bacteria were found either alone or in combination. Table 1 will show that *Streptococcus communis* was found most often (thirty-five cases).

A combination of *Streptococcus communis* and *Micrococcus catarrhalis* was the most frequent (twenty-seven cases). Next in frequency were: a combination of *Streptococcus communis* and *Staphylococcus aureus* (twenty-five cases); *Staphylococcus aureus* alone (eighteen); *Staphylococcus aureus* and *Micrococcus catarrhalis* (seventeen cases); pneumococcus (fourteen cases); *Micrococcus catarrhalis* (fourteen cases); *Micrococcus crassus* (ten cases), and finally a variety of combinations including organisms such as *Micrococcus tetragenous,* diphtheroids, unidentified gram-positive and gram-negative bacilli. Of chief interest is the fact that *Streptococcus communis* was found in ninety-seven of the 200 (nearly 50 per cent.),

either alone or in combination. This is in accord with our previous knowledge of the predominance of this organism in nose, throat and ear infections.

METHOD OF APPLICATION

The method of application varies according to the part to be treated. The chief objective is to get the vaccine as near to the infected part as possible.

In nasal conditions (other than direct application to the antrum), the applications were as follows: the nasal mucosa was first cleansed with hot alkaline solutions. It is better not to shrink the mucosa first with cocain or epinephrin, so that a large area of absorption can be left open. At intervals of from three to four days, the nares were packed with long strips of cotton gauze immersed in the vaccine. If the infection is chiefly high up in the nose—the type of infection which one sees in ethmoiditis—the packing is placed between the septum and the middle turbinate bone. The packing is allowed to remain in place for at least one-half hour and is then removed. In the intervals between office treatments, the patient is given a small amount of the vaccine to use twice a day at home in an atomizer. The patient should receive eight office treatments. Variations in this form of treatment may have to be made, particularly in children, in whom the vaccine may be instilled into the nose by means of a medicine dropper. It will make little difference if some of the vaccine is swallowed.

In antrum infections or in frontal sinus infections, one may clean out the cavity by thorough irrigation; then the vaccine may be instilled into the cavity and allowed to remain. A number of antrum infections have been treated in this way, with satisfactory results.

The treatment of throat infections has not been so satisfactory, mainly because there is no cavity into which the vaccine can be placed. In certain of these cases, the vaccine has been applied to the posterior nares, hoping that there would be some absorption through the lymphatics. I am not satisfied that this has occurred. Recently, someone suggested that the vaccine might be injected into the superior tonsillar fossa so that it reaches the loose areolar tissues external to the tonsil, but as yet this has not been attempted.

In treating ear infections, we have found that the instillation of the vaccine into the ear canal is sufficient for conditions of the external auditory canal and middle ear infections. For the treatment of the mastoid wound, the vaccine is instilled directly into the wound at each dressing and it is also applied as a wet dressing to the wound. In all other types of cases it is best to apply the vaccine as a wet dressing. We have found it far more beneficial than any of the antiseptics heretofore employed.

TYPES OF CASES TREATED

No attempt was made to treat a particular type of case. Whenever there was free pus, a culture was taken and a vaccine prepared. A glance at Table 2 will show the types of cases in which the vaccine was used.

There were eleven cases of throat inflammations and infections, among them being cases of pharyngitis, infected tonsils, laryngitis and nasopharyngitis. There were seven cases of combined nose and throat infections. By far the majority of cases were nasal infections, particularly infections of the accessory sinuses, which did not warrant operative interference other than the irrigation of an antrum in particular instances. There were nine cases of antrum infection alone, seven cases of acute inflammation of the nasal mucosa which did not respond to the ordinary simple treatment, cases in which there had been a similar infection a short time before. There were seventeen cases of ethmoiditis, both acute and chronic, fifty-two cases of pansinusitis, forty-two cases of subacute

TABLE 2.—*Types of Cases in Which Vaccine was Used*

	Number
Throat Inflammations:	
Pharyngitis, infected tonsils, laryngitis, nasopharyngitis	11
Nose and throat inflammations	7
Nasal Infections:	
Atrophic rhinitis	3
Asthma	4
Antrum infections	9
Acute inflammations	7
Ethmoiditis	27
Pansinusitis	52
Subacute inflammations	42
Chronic inflammations	5
Ear Infections:	
Eczema of canal, furuncles, acute mastoiditis, chronic suppurations, suppuration from old mastoid wound	16
Progressive deafness	14
Miscellaneous cases	3
Total	200

inflammations with a congestive condition of the mucosa over the turbinates and septum, and five cases of chronic inflammation of the nasal mucosa.

There were sixteen cases of ear infections other than progressive deafness. Among these were eczemas and furuncles of the auditory canal, acute mastoiditis (slow healing wounds), chronic suppuration from the middle ear and discharge from old mastoid wounds. In each of these cases the vaccine was applied locally to the infected tissues. In the cases of progressive deafness, we felt that an application directly to the eustachian tube and middle ear after the tube had been properly dilated by means of applicators and bougies, would do far more good than the application of antiseptic solutions such as mercurochrome-220 soluble or 3 per cent. silver nitrate. In these cases, a fine wire applicator

was wound with cotton and immersed in the vaccine. Then the applicator was allowed to proceed into the tube until it went well beyond the isthmus. In the future, it might be well to force more of the vaccine into the middle ear, a procedure which is attended by some danger and which must be performed with the utmost care.

I have appended three miscellaneous cases. One was an infection of the forearm, the second was a furunculosis of the forearm and the third was an infection of the hand. To these should be added a secondary infection following a malignant condition of the antrum. This case will be described in detail later.

TABULATION OF RESULTS

It has been my purpose, so far as it is possible, to determine whether the end-result was mainly due to the employment of the vaccine, or was due to other treatment and the natural resisting power of the individual.

TABLE 3.—*Tabulation of Results in Two Hundred Cases*

	Number of Cases	Per Cent.
Cured	61	30.5
Improved	92	46
Unimproved	10	5
Questionable	37	18.5
	200	100.0

TABLE 4.—*Results in Nasal Sinus Infections*

	Number of Cases	Per Cent.
Cured	23	33+
Improved	38	55+
Unimproved	8	12—
	69	100

For vaccine treatment the type of patient was chosen to whom ordinarily would have been given a vaccine hypodermically. This applied particularly to the nose and throat patients, but not to those with acute ear trouble, for it has been our experience in the past that vaccine treatment was of little use in aural lesions. I have added four cases which are outside this special field, mainly to find out whether the direct application of the vaccine would have a specific effect on infections elsewhere, as claimed by the original authorities.

Among the total of 200 cases, it was found that sixty-one had been cured, ninety-two had been markedly improved, ten were unimproved and in thirty-seven the result was questionable. In the latter class were included all patients who seemed to be better, but who still complained of definite symptoms (Table 3).

The results in nasal sinus infection are given in Table 4.

In Table 4 were included all cases of generalized sinus inflammation or infection, with the exception of antrum inflammations or infections per se. Some of these cases were diagnosed as ethmoiditis; others as pansinusitis, and most of them showed evidences of pus formation. In all such cases, it was found of great value to clean out the nose and sinuses by suction irrigation before applying the vaccine. We are satisfied that the vaccine accomplished a great deal more than the application of the usual antiseptics. When the infection seemed to be high up in the nose and in a part that could be readily reached without traumatism, the vaccine was applied on a long tampon of cotton similar to the Dowling treatment with protargin mild.

TABLE 5.—*Acute Inflammations of Nasal Mucosa*

	Number of Cases	Per Cent.
Cured	12	75
Improved	4	25
Unimproved	0	0
	16	100

TABLE 6.—*Chronic Inflammations of Nasal Mucosa*

	Number of Cases	Per Cent.
Cured	0	0
Improved	4	80
Unimproved	1	20
	5	100

TABLE 7.—*Subacute Inflammations of Nasal Mucosa*

	Number of Cases	Per Cent.
Cured	6	14
Improved	31	72
Unimproved	6	14
	43	100

The results in acute inflammations of the nasal mucosa are given in Table 5. These were patients who had repeated acute infections throughout the year.

The results in chronic inflammations of the nasal mucosa are given in Table 6. It may appear strange that there were so few of these cases. The reason is that, in the majority of cases, patients who had a chronic condition of the mucosa had an accompanying sinus infection.

The results in subacute inflammations of the nasal mucosa are given in Table 7.

in Table 7. In this class were patients who intermittently complained of irritation in the nose, with partial nasal obstruction at times. The mucosa usually presented a healthy appearance, but there was evidence of moderate hypertrophy of the mucosa.

During the year it was unfortunate that we had only three cases of atrophic rhinitis with crusting, all of which were markedly improved by the vaccine. However, Dr. Pullen, working in the Cornell University Clinic, has informed me that he has had excellent results and that he will soon make a report. Certain authors have used a local vaccine with success but in a different manner. Doniol-Valcraze and Leplat use the vaccine after scarifying the mucous membrane and then applying bile to set up an irritation, a procedure which we consider unnecessary. No specific organism was found in the ozena cases.

Four patients with asthma and an associated ethmoiditis were seen and treated; one of these was cured and three of them were improved. Again, one must be reminded that these were patients who formerly had been treated by the usual methods with no definite improvement.

Three patients with chronic suppuration from the middle ear (chronic tympano-otitis media with suppuration) were treated with the vaccine. One patient was cured, one was improved and one was not improved. This leads me to believe that this method of treatment has no superiority over any of the other treatments, particularly zinc ionization.

One patient with eczema of the ear canal was improved, and one patient with protracted furunculosis of the canal with pus was cured. Again, in these cases, no advantage can be seen in this method of treatment.

One case of acute tympano-otitis media with suppuration was cured by means of the vaccine. A vaccine is not necessary in the average case of acute suppuration, but I believe it is of value in those cases in which there is prolonged suppuration, and when there is a large enough opening in the drum to allow some of the vaccine to percolate into the middle ear.

The suppuration from the mastoid wounds lends itself particularly to this form of treatment. Here an infection is being treated, which can be reached directly either by dropping the vaccine into the wound, or by applying it as a wet dressing, or both.

In patients with suppuration from an old mastoid wound and recurrent infection of mastoid wound, two were cured and one was improved.

In patients with acute mastoiditis on whom operation was performed, with subsequent slow healing, six were cured.

In former years, it was often found necessary to apply some antiseptic on or into the wound. Surgical solution of chlorinated soda was often used, with beneficial results. Sometimes the wounds were so

pale and anemic, as a result of the lowered vitality of the patient, that no definite healing took place. It is in this class of patients particularly that the local vaccine is of great value. In one such patient operated on under local anesthesia, nine months prior to the writing of this paper, the mastoid infection was so severe that the entire posterior wall of the auditory canal was necrotic and could be freely separated. On account of the danger of injuring the facial nerve, it was deemed advisable not to remove this piece of bone at the first operation. Suppuration continued for a considerable length of time. A broth vaccine was prepared, and gauze immersed in this vaccine was inserted into the wound. Within one week the wound closed completely.

In all of the cases of progressive deafness, it is felt that the pathology of the eustachian tube is mainly at fault, and therefore we have adopted a routine treatment of the tube. The final step of the treatment is the direct application of 3 per cent. silver nitrate solution well beyond the isthmus of the tube. In thirteen cases, the vaccine was substituted. That ten of the patients improved was evidenced by tests with the audiometer; three made no improvement. However, this is no greater percentage of improvement than we have been able to get by the usual treatment. One will have to investigate a large number of cases before making any definite assertion.

I shall not comment on the miscellaneous cases except the case of suppuration from a secondary infection of the left antrum, after the removal of a malignant growth. A recital of this case is worth while, mainly because it is the one case in which it was proved that the relief was caused by the vaccine and nothing else. This patient had been operated on for a malignant growth of the left antrum by Dr. Douglas Quick at the General Memorial Hospital. The operation was performed through the mouth. All malignant tissue was removed, and the patient recovered sufficiently to return to his home in Porto Rico. A few months later, there was a great deal of pain in and around the eye. When I first examined him, the following signs were noted: marked edema of both lids with brawny induration; marked exopthalmos so that the eye seemed almost outside of the orbit; almost total blindness; a small fistula beneath the lower lid surrounded by indurated tissue, which led down into the excavated antral cavity from which exuded a creamy pus. Examination through the mouth showed the excavated cavity which was fairly clean, but in which areas of necrosis could be felt. Examination of the nose showed a severe ethmoiditis on the left side. I ordered irrigations of the nose with hot potassium permanganate solutions (1 : 10,000) every three hours, and suggested that a culture be taken and a vaccine prepared for local application. When I returned with the vaccine three days later, the condition had become so serious that I

suggested to Dr. Quick if the suppuration did not become less in a few days and the eye recede, that it would be better to remove the eye. Strips of gauze were saturated with the vaccine, which was applied through the mouth into the exenterated antral cavity. At the end of one week, Dr. Quick reported to me that the suppuration had ceased, that the eye had receded and that the sight had improved. Within a few weeks, the eye had returned to its normal position and, so far as I know, the patient is entirely well today. Surely a result such as this is worthy of attention.

CONCLUSIONS

In conclusion, I desire to emphasize the following points:

1. Cultures from the nose, throat or ear can be readily made, and vaccines prepared in broth.

2. A simple technic without isolation of specific bacteria will produce a practical vaccine.

3. The application of vaccines locally is a painless procedure, and acts directly on the tissues infected.

4. The vaccine seems to act more beneficially in purulent conditions which can be reached directly.

5. Nasal sinus infections seem to respond more readily than other conditions.

6. The local application to slow healing wounds, particularly to bone infections, seems to create an antiseptic and stimulating action.

7. The local applications of vaccines can be made in many cases, when patients will not submit to hypodermic injections.

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ABSTRACT OF DISCUSSION

DR. THOMAS S. WINSLOW, New York: In using these broth vaccines two questions arose. First, aside from their assumed property of stimulating antibody formation, are they of themselves antiseptic? To determine this, a Berkefeld filtrate was made from several of them and we tried to find the presence of a bacteriophage. In none of the specimens examined, however, could we demonstrate any. Of course, they may have been present in some of the vaccines we did not test. If they should be present, there is nothing in the way the vaccine is made to destroy them, as the bacteriophage is supposed to withstand a temperature of 70 C., and the vaccines we used were only heated to 58 C. In the absence of a bacteriophage, we do not see any other causes that could make the vaccines actively antiseptic. The second question was: If they are not antiseptic, would it not be dangerous to place this culture medium in a body cavity which was already infected, and thereby invite more energetic growth of the invading organism? To determine this point, Berkefeld filtrates of several vaccines were again made. These filtrates were of clear straw color. It was found that we could leave them in wide mouthed bottles uncorked, exposed to the air, and they remained clear and apparently free from any bacterial growth, except for an occasional mold. After four days of exposure

I cultured them and found them sterile. A streptococcus, *Micrococcus catarrhalis* and a staphylococcus were inoculated, but in no case did they grow. If, however, fresh medium was added to the filtrates these organisms grew very well. To find out the reason why the filtrates remained sterile we analyzed them and compared them to analysis of the original broth. The analysis showed two causes for the sterility: An acid reaction, and a definite loss of nutrient ingredients of the medium. This made us feel safe in using the vaccine in body cavities. A final point of interest in connection with these vaccines which I would like to mention is the type of bacteria we generally found. It was expected at first that we would be troubled with a lot of spore bearing organisms and saphrophytic types which could not easily be sterilized at the low temperature we used. I examined the sediment of every vaccine after it was prepared and was never able to recognize a spore. Only a few times did we see any of the gram-positive bacteria of outside contamination, and in culturing each vaccine after it was prepared I never found any growth. We were pleased to find that, as a rule, we got a good mixture of the recognized types of pathogenic bacteria, especially of streptococci and pneumococci.

DR. GEORGE PINES, Los Angeles: I would like to ask Dr. Hays about the actual dosage of the vaccine. I am using many vaccines in my work and it seems to be a rather unscientific method of dosage. Is a definite p_H determined before the culture is grown? Do reactions occur from the injection of these vaccines? Does the bacteriologist determine the number of bacteria to the cubic centimeter and know how much he is giving at each injection?

DR. ABRAHAM ZINGHER, New York: The question of increasing the local resistance of a tissue or mucous membrane by the direct application of bacterial vaccines, as suggested by Besredka, is very important, and would have great practical significance if the results of this investigator could be corroborated. As regards typhoid and paratyphoid immunization of rabbits by oral administration of bile and killed vaccine, I failed to confirm Besredka's claims five years ago. Similarly, his recent work on anthrax, in which he claims that animals can be infected through the injured skin or mucous membrane only, has not been confirmed by various investigators in Germany and in Belgium. It would seem, therefore, that the original basis for Dr. Hays' work cannot be accepted offhand, and the results presented by Dr. Hays' have to be judged on their own merit. We all realize how far reaching and important these results would be if they could be corroborated. Not only in otology but in many of the other surgical branches would the local application of such vaccines find their therapeutic applications. But unless thoroughly proved, a communication of this type would simply open the gates to another flood of commercial "shotgun" vaccines, to be applied this time locally rather than injected with a hypodermic syringe. Dr. Hays stated that he was not certain whether the good clinical results he noted were due to the bacteriophage principle of d'Hérelle developing during the growth of the cultures, or to the local immunization of the tissues according to the ideas of Besredka. As just stated by Winslow, there is no lytic principle in the broth culture filtrate. Aside from that, Dr. Hays recommends the use of a polyvalent vaccine made from the different bacteria infecting the open wound and which is obtained by means of a mass culture in broth. We all know what that would mean. Some harmless saprophytic bacteria may entirely overgrow the real pathogenic organisms, and the vaccine as prepared would not represent the true bacterial flora causing the infection. Dr. Hays states that what he wants to obtain and what the patients desire are practical results and not scientific principles. But true therapeutic results are based on sound scientific principles, otherwise we will have to agree with the patients who go with their ailments for relief to Christian Science healers, chiropractors, naturopaths and other nature fakirs, and who claim to have obtained relief in a practical way as a result of the ministrations of these therapeutic giants. While speaking on the subject of local immunity, I would like to draw your attention to

the natural local immunity of the intact normal mucous membrane of the nose and throat. It is important to remember that such an immunity is present and may protect a person from an attack of diphtheria, when the Klebs-Loeffler bacilli are present in the nasopharyngeal passages, even if such an individual has no general immunity—in other words, in a person who has a positive Schick test. However, if an operation, like a tonsillectomy, is performed, the local resistance is promptly destroyed and diphtheria is very likely to follow. Such a complication is doubly dangerous because it is likely to be overlooked owing to the similarity in the postoperative membrane with that of the diphtheritic lesion. Either a throat culture should be taken before the operation, and, if positive for Klebs-Loeffler bacillus, a dose of antitoxin should be injected, or one should make certain the person to be operated on is immune to diphtheria and gives a negative Schick test.

Dr. Alfred Kahn, New York: A few years ago I experimented, using a method in line with that described by Dr. Hays. Various strains of bacteria and toxins were used, and I feel that possibly there is something to be said in favor of this theory. I view it only theoretically, because I believe that anything that is done along this particular line in our present state of knowledge is absolutely experimental. I think in using mixed forms of bacteria, that there are certain times to use them and certain times when they are not to be used. The nose has the power not only of absorbing, but of excreting, and if you use a vaccine in the nose at the time it is absorbing (in the early stage of acute rhinitis, for example), then immunity is very often produced and the rhinitis is cut short. On the other hand, if the vaccine is used when excretion is taking place (in the third stage of rhinitis) there is no result. Speaking of mastoid wounds brings to mind a serum prepared by His some years ago for the treatment of infections, and which was also tried in the treatment of sarcoma. I mention His's serum because Dr. Hays spoke of a patient who was suffering with a malignant growth and on whom he used the substance he had prepared. His's serum was made from an extract of leukocytes, and was extensively used in combating infections, especially erysipelas. Hays's serum combated malignancy, he stated. His's leukocyte extract was thought to have similar power. His thought his extract had the power of healing mastoid erysipelas; but I am inclined to think that the fact that a mastoid wound infected by erysipelas heals faster is on account of some power inherent in the erysipelas inflammation. When a mastoid wound is infected by erysipelas, it undoubtedly hastens its healing. I have stopped the use of vaccines and allied substance because I had an unfortunate experience in their use, resulting in the death of a patient, following an intranasal infection, that I believe could be traced to the use of vaccines.

Dr. G. M. Waldeck, Detroit: I have used Dr. Hays's technic in about twenty cases since visiting New York last year. Most of these have been cases of nasal discharge, either in which operation was not indicated or in which operation had been refused. My results have not been as satisfactory, on the whole, as Dr. Hays's. I had one case of acute infection following a submucous resection, with temperature elevation, in which I feared the possible complication of meningitis. This patient showed marked improvement after the first application of the local vaccine, so that it was continued, and the patient made a nice recovery in a much shorter time than he would have if treated by the ordinary method. I have had two patients with asthma, both of nasal origin, which had been operated on quite extensively by Dr. Canfield of Ann Arbor, and in both cases the nasal discharge persisted. These cases cleared up and clean noses resulted, following a protracted course of local vaccine treatment. In one case the asthma cleared up and in the other case the asthma was apparently not affected. The reason I have not had as good success is probably because I have used only the filtered vaccines. I did not use the broth itself, because our laboratory technician thought there was a danger in using the broth culture after forty-eight hours without filtering it

and putting it in a saline suspension. He thought there might be an accumulation of diphtheria bacilli in forty-eight hours that might be of serious significance. A few diphtheria bacilli might form enough toxin in a forty-eight hour culture to be dangerous to a patient when applied to the mucous membrane.

DR. HAYS, New York: After we have grown the bacteria we always examine the sediment to see the type of bacteria present, and in the cultures we have made during the last year we have had no accidents whatever. I do not attempt to pose as a bacteriologist, and I do not know this subject as well as Dr. Zingher, but I am looking for practical results, and when Professor Besredka brought this out, I thought there must be something to it. I am satisfied that we have a method of treatment that is more than worth while in dealing with many cases of osteomyelitis, in sinus conditions in which operation is undesirable, in suppurative conditions of mastoid wounds either chronic or acute. Dr. Winslow brought out the question of bacteriophage. I wish I could discuss it. It would seem to me we are working on a far more extensive basis in using bacteria this way. Dr. Piness brought out the question of unscientific dosage. When you come to bacteriophage, it is worse than that. Although the dosage may be unscientific, and, in fact, I am not at all interested in knowing the types of bacteria that are present except from a pathologic point of view, nevertheless, when we take cultures from the nose and have a vaccine made, is not that as wise a use of vaccine as to attempt to isolate one or two organisms and inject them hypodermically? I am not looking at this from a bacteriologic point of view at all. Dr. Kahn brought out the question of the His extract. I feel very proud of the fact that a number of years ago I was a disciple of His, and made the first extract at the New York Eye and Ear Infirmary, but I think it has not much value so far as the discussion of this paper is concerned. Of course, I realize its value. This is an entirely new subject, and I want to bring it before you for the purpose of having others use the vaccine to see whether they can corroborate the statements I have made.

AUDION BULB CIRCUITS IN OTOLOGIC PRACTICE

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For many years there appeared very little that was new concerning the tests of auditory function. Recently, there has been an awakened interest. This has been brought about largely through the advent of the thermionic vacuum tube or audion bulb. Since this audion bulb has made a contribution to otology, and promises to have a still more extended usefulness, it would seem appropriate to present those features of this bulb that apply to otologic problems. The use of this bulb in providing more precise methods of diagnosis may be regarded as established. In addition, it would not seem too sanguine to hope that the future development of the uses of this bulb may make possible the realization of standardized auditory tests.

The use of the audion bulb is the basis not only of modern radio transmission and reception, but also of long distance telephony. In long distance telephony, two audion bulbs—a "two stage amplifier"—are employed about every 500 miles along the line. These amplifiers "step up" the enfeebled telephonic currents.

From the otologic standpoint there are two essential features of this bulb:

1. Telephonic currents can be amplified to such a degree as to overcome any conductive lesion of the external or middle ear and thus enable the sound waves to enter the cochlea.

2. Pure tones can be produced by means of the tube and an associated circuit. The pitch and loudness of these pure tones can be accurately controlled and measured.

The two essential features of the audion bulb, therefore, are its capability to act as an amplifier or as an oscillator. These two features provide facilities for more accurate measurements of auditory function than was formerly possible by means of the conversational voice and whisper, the ticking of a watch, tuning forks, monochord, Koenig rods or the Galton whistle.

The bulb is highly evacuated and contains three electrodes, namely, the filament, the plate and the grid. The filament is similar to the filament of the ordinary incandescent electric light. Such an incandescent filament emits electrons. When the filament alone is in the bulb, as in the ordinary electric light, these electrons are thrown out of the filament. However, as there is no field of force to pull them away from the filament, they fall back into it. As early as 1884, Edison introduced a plate

into an ordinary electric light bulb and found that when this plate was positively charged, by means of an external battery, an electric current flowed between the plate and the filament. The explanation of this phenomenon was later given by Sir J. J. Thomson and O. W. Richardson in their study of the flow of electrons in evacuated bulbs. Their explanation, which is fully accepted today, is that the negatively charged electrons, "boiled out" at the filament, are attracted to the plate, which is positively charged. It is this type of tube which Fleming and others used as a detector of radio waves.

The third electrode, the grid, was introduced by DeForest in 1907. The grid is placed between the filament and the plate. By giving positive or negative charges to this grid, the electron current to the plate is controlled. If the grid be positive, the electron current to the plate is increased. On the other hand, if the grid be negative, the electron current to the plate is decreased. By reason of the positive and shielding effect of the grid, small changes of electric potential on the grid are equivalent to larger changes of potential on the plate. In this way the tube acts as an amplifier. For example, a feeble telephonic current, impressed across the filament and grid of the tube, is faithfully reproduced and yet amplified from ten to thirty fold in the plate circuit. By passing a telephonic current through a series of audion bulbs, it is possible to obtain any degree of amplification.

By coupling the plate and grid through an appropriate outside circuit, electric oscillations of any desired frequency can be produced. To explain the action of the audion bulb as an oscillator, it is helpful to consider the analogy of the tuning-fork, with which we are more familiar. The oscillations of a tuning-fork are determined by the mass and stiffness of its tines. In somewhat the same way, the oscillations produced by the audion bulb circuit are determined by the outside circuit which connects the plate and the grid of the audion bulb. The outside circuit consists principally of an inductance coil and a condenser. In any electric current an inductance coil has certain properties of inertia, analogous to the mass of the tines of the tuning-fork. Similarly, in an electric circuit, the condenser has certain properties of elasticity or stiffness analogous to the elasticity or stiffness of the tuning-fork. By varying the mass and the stiffness of tuning forks, one produces tones of various frequencies. In the same way, by varying the value of the inductance coil and the value of the condenser, one is enabled to produce tones of all the frequencies throughout the entire range of audition. This is the basis of the use of the audion bulb for producing tones. The electric oscillations produce vibrations of the diaphragm in a telephone receiver. These vibrations produce a tone. No tone is produced by any portion of the mechanism except the vibrating diaphragm.

These two features of the audion bulb, as an amplifier and as an oscillator, are applicable in otologic practice as follows:

1. Amplification of the conversational voice or whisper.

(*a*) Selective amplification, whereby the various frequency components of the spoken voice can be amplified.

(*b*) Better artificial aids to hearing.

2. Production of pure tones for testing hearing, both by air conduction and bone conduction.

3. Convenient means for controlling and measuring the loudness of either speech or tones. This makes possible precise measurements of:

(*a*) The nature and degree of a hearing defect.

(*b*) The pitch and loudness of certain types of tinnitus.

(*c*) The pitch separation of diplacusis.

(*d*) Progressive degenerative changes.

(*e*) The effect of treatment.

AMPLIFICATION OF THE CONVERSATIONAL VOICE AND WHISPER

Whether one uses the conversational voice or the whisper or for that matter, any desired tone, the amplification which can be attained by the audion bulb circuit is capable of overcoming any interference in the conductive apparatus of the external or the middle ear. In this sense, one is enabled to test the cochlea directly. Such a direct test of the cochlea is analogous to the direct test of the vestibular portion of the internal ear by the caloric test. If the "deaf" ear can hear the faintest whisper by means of the amplifier, it becomes obvious at once that the cochlear function is good. Incidentally, if amplification enables the "deaf" ear to hear perfectly, it becomes evident that there exists only a lesion of the conductive mechanism.

On the contrary, a lesion of the cochlea is suggested if the patient complains that the "words all run together and sound confused," or complains of excessive reverberation, or that the loudness is distracting or even painful, or that loud sounds are heard but that the words are unintelligible.

Selective Amplification.—"Uniform" amplification signifies that all the frequencies which make up speech or music are equally amplified. "Low-pass" amplification signifies that the low frequency components of speech or music are given greater amplification than the high frequency components. On the contrary, "high-pass" amplification signifies that the high frequency components are given greater amplication than the low frequency components. It is in fact, possible, by introducing suitable distortion circuits to amplify any desired range of frequencies selectively.

In testing hearing by means of an amplifier, it is possible to utilize this principle of selective amplification. One can simply speak into a transmitter and, at will, regulate the degree and nature of the amplification of one's own voice. On the one hand he may cause a large amplification of the lower frequencies, or, on the other hand, he may cause a larger amplification of the higher frequencies. This furnishes a convenient method of determining whether the patient's hearing defect is more marked for the low frequencies or for the high frequencies.

Better Artificial Aids to Hearing.—By means of the audion bulb and its appropriate circuits, one is enabled to amplify speech or music to any desired degree. The present difficulties in obtaining perfection lie, not in the audion bulb, but in the limitations of available transmitters and receivers. Even now it is possible to build laboratory amplifiers which will provide a great amplification with practically no distortion. Such more or less ideal instruments are costly and bulky. However, it is already possible to construct a portable instrument that is fairly satisfactory.

Under all circumstances, such an amplifier is only of slight value to an ear, whose cochlea is much impaired. It is the person with fairly good cochlear function whose hearing impairment is largely one of the conductive mechanism who receives the full benefit of amplification. If appropriate amplification conducts normal stimuli to the cochlea, he is enabled to hear. Here again comes up the matter of selective amplification. In a case of conductive lesion in which the tests have shown a relatively great impairment for the low tones and a relatively slight impairment for the high tones, selective amplification would appear to be of distinct value as compared with uniform amplification. Theoretically, one would expect in such a case that "low-pass" amplification would tend to equalize the loudness of all frequencies as they enter the cochlea. In clinical practice, however, experience has shown that such selective amplification does not make such a difference as one would expect. In many such cases the patient states that he hears as well with uniform amplification as he does with "low-pass" amplification.

The ear regarded as a physical instrument, presents many unsolved difficulties. The science of acoustics has not been developed to the same extent as the science of optics. For years the science of optics has attracted many investigators; much active work has been done by physicists, physiologists and ophthalmologists in the study of the eye as a physical organ. Most of the defects of the refractive mechanism are well understood and are now capable of precise measurement and correction. In contrast, all devices which have been invented for amplifying sound, introduce distortions. These distortions, whether caused by a horn or by a diaphragm, cause an overemphasis of certain tones. A

narrow band of frequencies receives great amplification and the frequencies below and above this favored range are amplified much less, and in some instruments not at all. All such instruments, therefore, tend to distort the physical characteristics of speech or of music. The development of the science of acoustics and the utilization of the audion bulb appear to afford a brighter prospect in the designing of artificial aids to hearing.

PRODUCTION OF PURE TONES FOR TESTING HEARING BOTH BY AIR CONDUCTION AND BONE CONDUCTION

Up to the advent of the audion bulb, the only means of testing the cochlea more or less directly has been by bone conduction, with a tuning fork. In such bone conduction tests, however, a conductive lesion introduces a fallacy which it is difficult to estimate. In addition, tuning-fork tests of the cochlea, by bone conduction are limited to relatively low frequencies. In contrast, tests of the cochlea by air conduction, with the use of the amplifier and the oscillator, may be made throughout the entire range of audition.

PRECISE MEASUREMENTS

The main contribution of the audion bulb to otology is that it makes possible a more precise and yet a rapid determination of the type and degree of a hearing defect. By reducing the loudness of speech or tones to the minimal threshold of audibility, one is able to make a quantitative estimate of function. Again, because of the fine gradations of tone which the audion bulb makes available, one is, in some instances, able to determine the exact pitch and loudness of a tinnitus. By the same facilities for precise measurements, one is enabled, not only to demonstrate the presence of a diplacusis, but also to determine whether one or both ears hear "off pitch." One is also enabled to determine the pitch separation in the two ears.

Making such tests with the audion bulb as an amplifier or as an oscillator, or both, one is not only enabled to make nicer discrimination in diagnosis, but also to estimate the progress of the involvement of the cochlea caused, for example, by a disease such as syphilis. One can also estimate the results of treatment of deafness, whether by surgery, local measures or internal medication. At the present time, many claims are being made as to the beneficial results of various forms of treating deafness, such as roentgen ray, diathermy, and various electrical and tonal treatments. The beneficial results that are being claimed would receive more credence if precise measurements were made before and after treatment. It is generally acknowledged that one should not rely on the statement of the patient as to whether he hears better. Through the audion bulb, such precise measurements are now available.

MEANS AND METHODS OF TESTING IN AURAL DISEASE*

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MATTERS GERMANE TO TESTING

Before I deal with the true substance matter of this paper, there are a few points to which I would direct attention, and foremost is that most interesting phenomenon of nature—sound. Not only is every human voice different; as an external configuration, family characteristics occur, so often in voice the same applies. One can tell by sound what variety of musical instrument is being played, and frequently distinguish the up from the down stroke note on a violin. In this instance there is a variation in the timbre of a note, due to a physical alteration in the string from which the sound is produced. The string is of twisted gut, the up stroke going in the direction of the twist tends to tighten the string, the down stroke on the other hand, tends to loosen or undo the twist. But the difference in the overtones produced by the up and the down strokes is most marked. Overtones are what give timbre, quality and distinction to sound. They give it the beauty or the character. The most ravishing notes as well as the most discordant sounds depend on these self-same overtones; those produced from the most perfect of grand pianofortes, an upright grand or a derelict neglected cottage instrument, although having in theory the same overtones, in practice are very different things.

As a further example, how easily even the untrained ear picks out the notes of a wooden instrument from a metal one, the sounds of a piccolo from a flageolet, and how absolutely distinctive an utterance has the organ.

The sense of sound perception, especially in regard to music, is as varied as the sense of color in painting.

This musical sense is partly congenital, partly affected by environment and partly received by training.

Then too, as with the other special senses, so with hearing, one finds persons who are congenitally deficient in the capacity to hear higher notes than a certain pitch. I can give an instance of such a case. Naturally, one has not always the opportunity and time to test accurately. The case I had in mind was that of a youngish man who asked my opinion with regard to the hearing of one ear which had recently been operated on. In the course of my investigation I employed the

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Galton-Edelmann whistle and found his upper tone limit was 12,000 vibrations per second. I then inquired if he was musical; to my intense astonishment he replied in the affirmative. "But," I told him, "you cannot appreciate a violin!" for the beauties of a violin tone are obtained by the greatest possible development of these overtones. "A violin, no," he said, "I never could make out what people heard in it!" Here was a musician, a singer, who could not know the beauties of sound as others do.

But most interesting in this connection is the effect of heredity. Races are musical or unmusical. For example, take Great Britain. Some parts are musical, some are devoid of music. Where the Celt is still in evidence, one finds there more natural expression and appreciation of music than in counties in which no trace of them remains.

Environment alone cannot do much for the musical development of the individual. One must have either a capacity to develop the musical sense or a real desire to do so, or preferably both. Patience is essential, but I am convinced that much could be accomplished by training, even with uncompromising material, if it could be shown to be worth while.

In this connection there are various forms of instruments made for the so-called reeducation of the deaf. They vary in their usefulness, but they all fall far short of being really valuable; though extremely useful on occasions, they are unreliable and perniciously expensive, and are not all harmless. But they have proved to us who have used them, that, despite the fact that they are readily made subservient to charlatanism, the possibilities of reeducation are real and of unknown potentialities.

What will be accomplished by the employment of wireless telegraphy is on the knees of the gods. It seems as if wonders may be in store for the deaf mute by means of broadcasting; or some special lessons may be broadcast on a low number of vibrations and in limited area.

TESTING WITH THE HUMAN VOICE

Many years ago, I suggested the employment of phonograph records (a standard phonograph would also be necessary), but I could not get them made. Still, I think it must be done, if ever we are to get a speech test worthy of credence. Again it has often occurred to me that the examinee and examiner are of a different race; as often, possibly more often, they come from different counties, and although using the same speech there are differences of pronunciation and inflection. Voices vary in their carrying power, people vary in their clearness of diction, in their attention to detail, such as using a level pitch in making tests. I once saw a child and advised that further treatment was doubtful, as no improvement could be obtained by the means of any of my

attempts. The child was taken to an eminent physician; his mother told me that he whispered to the boy, and the boy could not hear; he then inflated the eustachian tube and shouted the same sentence; mirabile dictu, the boy heard. The mother, however, was too observant. Now I am by no means sure that the mother's contention that the difference in the loudness of the tests was deliberate; indeed, I often fancy that I am at times a little inclined to assist the desired improvement. These are a few of the reasons for a standard record, given with a fixed intensity or volume of sound.

THE USE OF SOUND DEADENERS OR NOISE PRODUCERS

A very real difficulty occurs in testing people with unilateral deafness. For, however carefully one obstructs, or attempts to obstruct the healthy or healthier ear, one cannot be certain that the sounds used to test the unhealthy ear do not penetrate to the healthy one. In this connection one can say that in cases of absolute unilateral deafness, the younger the afflicted person is, the more difficult detection is, the more completely a person becomes monaural with a greatly increased range of sound or perhaps I should say, area, and a greater bone transmission of sound. In such cases, the noise producer, or even the noise of a watch pressed firmly into the external meatus, or against the auricle, will be of decided and definite value.

When employing noise producers, in attempting to test in disease, we meet two difficulties, namely, that in middle ear disease the noise increases the patient's power of audition, but in instances of internal ear disorder, the reverse applies. I am sorry to say that I am out of conceit with the value of the noise producer, and I look forward to the time when a more efficient means is found of eliminating sound from one ear.

HEARING TESTS AND THEIR EMPLOYMENT

It is of the utmost importance that we reduce all hearing tests to their simplest form. Simplicity is, however, only to be attained after much work, in order to obtain knowledge as what to retain and what to reject.

As a preliminary, a few remarks about some of the more important errors which are likely to crop up in their application will not be out of place; these remarks, however, being more applicable to the use of tuning forks than to the employment of other methods.

To commence with, the tuning fork itself, as employed in present-day otology, produces a sound which is foreign to, or unknown in nature; that is to say, the sound waves it produces should be absolutely free from the presence of overtones. One even occasionally finds people who are unable to hear any tuning forks at all, yet who are able to hear the human voice. They cannot hear so pure a tone—deaf people hear a

small object dropped which makes a noise, a mass of irregular vibrations, but they cannot hear a musical note. A question of degree in impurity!

With regard to the errors to which I have alluded, those come under the errors of the examiner and the errors of the examinee. In artillery work, with quick firing guns, it used to be a rule before practice, to obtain what was termed the gun layer's error for the day, that is to say, it was recognized that a man was not always equally good, but that he was liable to errors due to his mental or physical condition, which would cause him to be slower or less accurate than usual. When this error was found, this amount was applied to the range. In the same way, one must always consider the fact that, with us also, small things may alter the perception of the tuning fork, both to the observer as well as to the observed. The principal causes of diversions of results between any two observers, which I am terming the error, comes from the inequality in strength with which the tuning fork is struck to cause it to vibrate, or with which the tuning fork is pressed on the skull of the patient. In striking any tuning fork, it is always possible to obtain a large number of overtones. Bezold maintained that the presence of these overtones did not militate against accuracy of observation. There, however, I disagree with him, for I think it extremely likely that in many cases, when employing tuning forks of low range, that the cochlea would be stimulated by overtones and eventually a false estimate would be the result.

The position in which the tuning fork is held toward the ear, and the place at which it is struck, are of importance. It is well that the observer should, so far as possible, adopt absolutely uniform strength in hold the tuning fork on to the head, and a uniform position for holding it.

The elimination of the error of the strength of the blow used to set the tuning fork in vibration has been brought about by means of the spring hammer, applied by Lucae to his forks. By this means a constant blow is obtained, and if the weight of the tuning fork and its dimensions are constant, the duration of the sound will be constant, and by implication the amplitude of the vibration; thus one easily obtains a standard length of time for which the vibrations of any particular tuning fork should be heard when applied to the bone or presented to the ear. The matter of the aforesaid pressure is of some importance, and it is probably better for everybody to use what they would consider a firm pressure on the skull, that is to say, a pressure which should be short of causing any discomfort to the patient. In this method we shall probably have a small error between a score of observers, which would not be enough to cause any diversions in results. The weight of the tuning fork is of great importance, for the heavier the tuning fork, the greater the

amplitude of its vibrations, and it can only be by having an agreed standard weight of tuning forks that we shall ever obtain uniformity of results. If one compares the size of a Hartmann's tuning fork, together with that of an Edelmann of approximately the same number of vibrations, or at any rate, in the same octave, it may be easily seen that the difference in strength or amplitude of the vibrations is so enormous that one can well understand how great is the error between two observers, using different classes of fork. Therefore, it is not scientifically or practically correct for anybody to state that a patient cannot hear certain tones, when speaking of the results of tuning fork tests, unless he has always used the heaviest tuning fork of that note obtainable, for the more sluggish the nerve, the greater the amount of stimulus required to initiate a response. Hence, by using a heavier fork, one observer can obtain a result unobtainable by another.

Therefore, if at any time a serious attempt should be made to standardize the testing of the hearing, I would suggest that the heaviest tuning forks obtainable be made the standard pattern, and that no departure from this pattern be permitted.

With regard to the patient's errors, one has to consider his temperament, whether he thoroughly comprehends the question which is put to him, and if he thoroughly understands what is required of him. For these reasons, it is always advisable that tuning fork tests should be repeated as to the bone and air conductions, even repeating the test two or three times, until one is satisfied that the answer given is correct. Occasionally, one finds that at each bone testing the duration time the fork is heard becomes shorter, then it is known that one is dealing with a case in which the nerve is fatiguing with extraordinary rapidity. A pause should be made and the examination continued; later, a single bone conduction test should be taken, and accepted as the most accurate that the patient is likely to give.

This opens up an important point in a deduction to be made from the results of tuning forks, that is, the existence of a condition in a large number of patients, which shows that the auditory nerve fatigues at a more or less rapid rate. This rate of fatigue is what I have christened "fatigue period," and can be represented in the form of a percentage, and is obtained thus:

When a vibrating tuning fork is placed on the patient's mastoid, and the time that it is heard by the patient is taken by means of a stop watch, one will frequently be quite certain that this time is not correct; it is not what one's judgment would expect. The next procedure is to start the tuning fork vibrating and to apply it again to the mastoid in the same place and with the same pressure as the first time, but not until it has vibrated for as long as it was previously heard through the

bone; the time that it is then heard is now observed and recorded. Say, for example, that to begin with, in a case in which one expected prolonged bone conduction, the tuning fork was heard only for twenty seconds (20″), and a tuning fork employed the normal bone conduction of which is twenty-five seconds, the tuning fork is then struck and at the end of twenty seconds is again applied to the patient's mastoid. It will often then be found that the tuning fork will continue to be heard for another twenty or twenty-five seconds, so one has in this case a prolonged bone conduction, together with a fatigue period of approximately 50 per cent. This fatigue period, almost invariably a neurasthenia, although perhaps not yet noticeable elsewhere, often gives warning of the approach of a nervous breakdown; this neurasthenia may also be due to toxic influence, but, whatever the cause, it is necessary that the nerve fatigue should be eliminated before a diagnosis is attempted to be made from tuning fork reactions.

The Marconiphone, and probably all the electrical diagnostic aids in deafness, are useful chiefly in middle ear deafness. In fact, with the Marconiphone alone one is able to differentiate immediately between nerve and middle ear, for the patients with middle ear trouble can invariably hear better with it, whereas those with nerve trouble are not improved, or even hear worse when employing it.

I have not been able to investigate the apparatus, which is being produced by the Western Electric Company, in order to enable a diagnosis and estimate of degrees of deafness to be made, even by those who are ignorant of matters aural.

To proceed with, the various well accepted, or acknowledged tests, are known by the names of their originators. The test of Rinné is over sixty years old, and in those early days, tuning forks were extremely badly made, very impure in tone, and tone itself was not fixed. Rinné merely states that a tuning fork is to be used, and not a word with regard to the pitch. I spent a lot of time over this test, and evolved a scheme to show the number of subdivisions into which the test could easily be divided, which came to no less than six, and even then I had not exhausted the possibilities. (It is only within the last three decades that the English and Continental pitch agreed; then pianos were specially tuned for concerts about a semitone higher and called concert pitch.) So it will be quite obvious that if this tuning fork test (Rinné) can be divided into six, instead of remaining one, no definite diagnosis can be made from it alone. This test should always be done in duplicate, employing two forks, one tuning fork 128 double vibration, or a lower octave, and one 512 double vibration, or a higher octave. If tests are made with each of them, when both are negative, the indication is that the stapes is fixed—a distinctly useful piece of information.

With regard to Weber's test, I think this is quite useless. I do not think there is any object in using any other form of tuning fork test, with regard to the relative duration of air and bone conduction, than the Rinné, except Bing's.

Bing's test, the actual detail of whose method is variously defined, consists in ascertaining whether the bone conduction of sound is of longer duration or not, than that communicated to the cochlea through an enclosed column of air, which is obtained either by putting the end of the tuning fork into the external meatus, or by pressing the finger into the external meatus, then placing the tuning fork on it after it has ceased to be heard through the bone. To my mind, this is the most valuable tuning fork test which we possess, for if in a case of deafness, the bone conduction is longer than that through the column of air, it is then a positive indication of nerve deafness, and it appears to me that this is correct in all cases.

The so-called Gellé's test, which was used to demonstrate the condition of the foot plate of the stapes, is, to my mind, absolutely valueless. The sources of error in this test are so gross that accuracy and reliability are absolutely impossible.

I have not employed the modified Gellé, as advocated by B. Pearce Strum and Escat, and the result is that no criticism on my part is available.

After tuning forks one has the monochord. If the monochord is employed with a little care and the relative proportions of air and bone conduction taken, one has the most reliable indication of the condition of the auditory nerve, far more reliable indeed than that given by any tuning fork test, except that of Bing, for I have never yet found any diversions between these two. If reduced to one test alone, to define between a middle ear and nerve disease, I would invariably select the monochord, as the sounds one gets out of the wire are much less liable to be confused with others by the patient, and the difference between feeling and hearing does not obtrude itself. The monochord, however, has its disadvantage, it does not show the fatigue period; here I add to what I have said with regard to the fatigue period, that is, that when one has demonstrated it, one should invariably cease investigations, and should not resume them until by treatment the fatigue period has been practically eliminated, whether by the removal of a septic focus or by the relief of the neurasthenia. No opinion can be given on insufficient premises.

Then there are the so-called pipes or whistles, of which there are three, the larger pipe goes from A2 to A3, the smaller from A3 to A4, and the Galton-Edelmann Whistle goes up to 40,000 vibrations per second. Now I consider that the lower two pipes or whistles are of

distinct value, especially in those cases in which people have difficulty in hearing the tuning fork. I do not consider that the Galton-Edelmann whistle is of great clinical utility, though of great value from a purely scientific point of view.

Tuning forks much heavier than those usually employed are manufactured which are usually struck by means of the spring hammer. These tuning forks are distinctly of value in different cases in which a high stimulus is required in order to elicit any response, and are, therefore, of value in accurate diagnosis in cases of severe nerve deafness and in congenital deafness. A bell is occasionally of use. It is supposed to be of use in the testing of deaf mutes—of this, however, I am not at all sure. I have never found it of value except in cases of hysterical deafness, when, if a great and sudden sound, such as that of a large bell, is made behind an unsuspecting hysterically deaf person, one is, occasionally at least, able to detect either a fleeting smile or a movement of the eyes. This was used during the War, I believe, employed as an arbitrary test to prove that a patient was malingering—a most unjustifiable assumption if uncorroborated.

The most valuable test, however, which we are able to apply in cases of deafness or disorder of hearing is the spoken or whispered human voice. It is the only test in which the sounds are of value in every day life. In order to obtain a record of a patient's hearing of the voice and whisper, it is as well if possible that the room should be of some considerable size, and that the acoustics of that room should be fairly good. The distance then is taken from which the patient is able to hear and repeat words spoken by the observer without undue delay, the ear which is not being examined being tightly closed by means of a piece of "Shooter's wax" (spermaceti wax mixed with finely divided cotton wool). The patient should never be allowed to stand within three feet of a wall on account of the reflection of sound. A silence room in the proposed new building, which is to house the conjoint Royal Ear Hospital and the Ear, Nose and Throat Department of the University, is to be constructed with great care. It is hoped that it will not only be impenetrable to sound but one from which reflection and refraction of sound will be absent.

It is obvious that there are but few consulting rooms, comparatively speaking, in which voice tests can be carried out with anything approaching reliable accuracy or by which similar results would be obtained by another examiner in a different room. The whisper should aways be made with the residual air and the records of that should be entered in the same way as those obtained by means of the voice. In children, in whom it is often only by means of the whisper test that any departure from normal hearing can be detected, one will often notice that the

child makes a perceptible pause before repeating the word, although the word is repeated quite correctly, and if a stop watch is employed by the observer it will be found that this pause is often at least a second, instead of being of such rapidity as being absolutely untimeable. This, of course, is caused by a sluggish action on the part of the so-called perceptive mechanism of the ear, as well as of the receptive, and is not due to want of attention. It is generally advisable, I think, not to use numerals in voice testing, for people seem to guess them with greater precision than other words, but it is doubtless extremely difficult not to get into the habit of using a regular number of what one might term stock words, because, after having tested a patient three or four times, he will get to know fairly accurately what words to listen for, and will then necessarily often unwittingly deceive the observer. The accoumeter, which is a substitute for a watch, is, I think, of very little value. The watch also I do not think is worth employing.

SUMMARY

Let me now take the indications which one should be able to derive from the various tests, and then it will be seen how, by placing them together, one is able to give definite opinions.

I have not mentioned the paracusis willisii, as this is a symptom and not a test, but its existence should always be noted as it has an important bearing on diagnosis.

First, with respect to the results from Rinné's test. When using the lower note tuning fork, Rinné's test is negative; if this is uncorroborated by the one in the highest octave the condition probably is an early middle ear trouble, the prognosis is hopeful and the stapes is not fixed. If, however, it is corroborated then the stapes is fixed. If it is positive, then this result unsupported by the results of other tests is valueless, although in no case can one fairly give an opinion capable of proof from this test alone.

Bing's test, as I have already mentioned, is one of great value, and if positive, that is, when the bone conduction is longer than that of the closed column of air in the external meatus, the condition is one of nerve deafness, and if results are supported by that obtained from the monochord the diagnosis is unassailable.

The monochord is employed or read in much the same way as a tuning fork, the relative duration of bone conduction to air conduction. When the air conduction is reduced and the bone conduction not affected or not materially so, the condition is probably middle ear trouble; if, on the contrary, the bone conduction is affected the condition is nerve disease, subject to corroboration, of course, by other tests.

With regard to the voice and whisper, these tests are of value not only as tests, but as records by means of which the value of any improve-

ment which is made can be amply demonstrated as well as by the fact that there is between the voice and the whisper a well-known and accepted ratio, which in deafness of middle ear origin shows that the perception of the whisper is depreciated out of all proportion to that of the voice, whereas in well-marked nerve disease the reverse occurs.

With regard to the diagnosis, therefore, of a middle ear deafness as compared with a nerve deafness, one would find the voice in the former not so much diminished in proportion as the whisper much diminished; in the latter the voice is very much diminished, and the whisper is good as compared with the voice, often being heard at an equal distance as that of the speaking voice. Paracusis willisi, in cases of middle ear deafness of high grade is noted, whereas in nerve deafness the presence of sound makes the patient hear worse instead of better (with the exception of boilermakers' deafness). Bing's test in the former case is negative, in the latter it is positive. Rinné's test in the former will be negative the moment the disease is defined, and when the stapes is fixed the Rinné test will be negative also with the higher tuning fork, whereas in nerve deafness Rinné remains positive except in the higher grades. Bone conduction will be lengthened in the middle ear and remain unaffected or be diminished in nerve trouble. The fatigue period I have already alluded to at length. In air conduction, the lower tone limit will be raised in middle ear disease, and the upper tone limit will be lower in nerve disease, though in well pronounced cases of severe middle ear disease the upper tone limit will be lower as well as the lower tone limit raised.

In old people, certain changes take place in the bone, which cause a steady diminution in the length of the time a tuning fork is heard through the bone in a large number of cases. The duration of the tuning fork will be diminished by a matter of more than 50 per cent. This, however, does not indicate disease but merely a change in the composition of the bone, and the deafness of old people is as often due to the rigidity of the ossicles as to disease.

ENDOSCOPY

ITS USE AS AN AID TO GENERAL DIAGNOSIS IN DISEASES OF THE THROAT AND THORAX *

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The field of usefulness of peroral endoscopy as an aid to general diagnosis of diseased conditions in the throat and thorax has increased extensively in recent years.

While specialists in this particular line of work fully appreciate the information which may be obtained by examination with the direct laryngoscope, bronchoscope and esophagoscope, there are many of the medical profession who do not realize how much might be gained by a single endoscopic inspection in many of the obscure conditions affecting the upper air and food passages. So many articles have been written and so much attention has been directed to the foreign body phase of this subject, that the routine use of these instruments for diagnostic purposes in many common diseases is generally unappreciated.

In this paper, several cases showing the practical value of endoscopic examination in an average practice are presented briefly. All unessential details have been omitted from case records, except the notes relating to this particular part of the subject. Foreign body cases have been purposely omitted from this series.

ACUTE INFLAMMATORY CONDITIONS

A frequent symptom encountered in young children is some interference with breathing. Often it is nothing more than simple or spasmodic croup, while in other cases the condition may be very serious, and the only satisfactory way of making a diagnosis is by direct laryngoscopy and bronchoscopy.

Indirect laryngoscopy cannot be used in young children, while examination with the direct method is an easy procedure. No anesthetic is necessary and only a short time is required for accurate investigation.

In every case of suspected laryngeal diphtheria, it is important to have a direct laryngoscopic examination made.

At the present time, when the removal of tonsils is such a general practice, it is not uncommon to have severe laryngeal diphtheria with little or no membrane in the pharynx or upper part of the larynx. Cultures from this region may be negative, so that the only early and satisfactory way of making a definite diagnosis is by the use of the laryngoscope and bronchoscope.

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* Thesis, American Bronchoscopic Society, 1925.

One of the advantages to be gained by this procedure is, exact inspection. Cultures can be taken from the deeper structures and local treatment applied. Suction can be used and dyspnea relieved instantly with a bronchoscope and intubation tubes inserted directly.

REPORT OF CASES

CASE 1.—C. M., a boy, aged 9 years, demonstrated the value of endoscopy. This patient was recently seen, in consultation, for the relief of difficult breathing.

The usual examination of the pharynx and upper part of the larynx had been made, no membrane could be made out and cultures were reported negative for Klebs-Löffler bacilli.

Examination with a direct laryngoscope revealed a grayish membrane below the glottis which suggested diphtheria. A tracheotomy was deemed advisable, and on cutting into the trachea a great deal of purulent exudate was expelled, which was found to be filled with diphtheria bacilli. Antitoxin was given and the patient made an uneventful recovery.

CASE 2.—A child, aged 2½ years, was sent to the dispensary because of dyspnea. Diphtheria was suspected and the patient was sent at once to the hospital for contagious diseases, where intubation without a laryngoscopy was performed, and antitoxin was administered.

After the usual time the child was discharged from the hospital as cured, but a few days later was brought to me suffering from symptoms similar to those presented at the first visit to the dispensary. On making a direct laryngoscopic examination, considerable infiltration of the mucosa of the glottic region could be made out, which presented a picture of benign inflammatory hypertrophy. No doubt, antitoxin and quarantine would have been unnecessary at first if a direct examination had been made. This condition soon cleared up under local applications of argyrol.

CASE 3.—This case shows the practical value of this procedure in differential diagnosis. A consultation was requested on an infant, aged 6 months, to determine the cause of difficult nursing and swallowing. On examining the throat by the ordinary methods and palpating with the finger, nothing was made out. Roentgenograms were negative. The child was so small that a direct laryngoscopic examination was not made, and as it had been breast fed since birth and had history of infection, an abscess was not suspected. The child died and necropsy showed a deep retropharyngeal abscess as the cause of obstruction. The child's life could have been saved if a direct laryngoscopy had been used to locate the abscess, when it could have been successfully drained.

CASE 4.—J. S., aged 5 years, had frequent coughing spells, during which there was considerable interference with breathing. Inspection showed an acute catarrhal inflammation of the larynx and trachea which was relieved by a few local treatments.

Congenital malformations are often the cause of obstructed breathing and delayed voice development in children. Direct laryngoscopy is obviously quite necessary here for proper study and treatment.

CASE 5.—A boy, aged 10 years, from a country town, was referred to me to determine the cause of his speech disturbance.

Laryngoscopic examination showed congenital webs across the vocal cords as the source of trouble. Operative treatment removed the obstruction, allowing the voice to proceed with normal development.

CASE 6.—J. L., a youth, aged 16, gave a history of coughing up great quantities of foul smelling pus at frequent intervals, but more often in the morning. Examination demonstrated that pus was collecting in the bronchi, the result of drainage from an infected antrum and a chronic suppurative otitis media. After eliminating the infection above, bronchoscopy with suction and irrigation was used

which soon cleared up the bronchial infection. This boy gained rapidly in weight and the cough and expectoration disappeared.

CASE 7.—A youth, colored, aged 20, came into the dispensary with multiple papillomas almost filling the larynx. Several attempts had been made to remove them with a snare by the indirect method with little success. By the direct procedure, the masses were easily removed and the bases cauterized.

Papillomas of the larynx are fairly common and can be easily diagnosed by the ordinary laryngeal mirror. However, the successful removal of them depends on direct methods.

CASE 8.—Mrs. H., aged 28, complained of pressure symptoms around the trachea. External examination showed only a moderate enlargement of the thyroid, with no exophthalmic symptoms. A neurotic condition was strongly suspected until a bronchoscopic examination was made which revealed extensive pressure over the right side of the trachea. Operation was decided on, and when the goiter was removed it showed that hypertrophy of the right lobe of the thyroid gland had extended to the right and posteriorly, producing the pressure symptoms complained of.

Thyroid cases, presenting any obstructive symptoms should always be subjected to an endoscopic examination, for frequently valuable information can be obtained.

CASE 9.—W., a man, aged 26, had a small contracted epiglottis with edema of the left arytenoid and the left cord. It was impossible to cauterize the lesions accurately by indirect means, but with the direct method the affected tissue was easily cauterized.

CASE 10.—C. M., aged 29, with a superficial tuberculous ulcer of the left cord, which was cured by direct cauterization, demonstrates another type of laryngeal tuberculosis in which it is safest to use the direct method.

The successful diagnosis and cauterization of certain cases of laryngeal tuberculosis depends on the use of the direct method. It is true that most of the cases can be treated by the indirect technic, but in lesions of the cords or below, or in cases in which there is much contraction or deformity of the epiglottis, it is frequently necessary to resort to direct procedures before the area can be cauterized.

In such cases we are anxious to preserve as much cord structure as possible, therefore the method should be used which insures the most precise application of the cautery point.

CASE 11.—S., a man aged 78, was sent to a surgeon for relief of hoarseness and difficult breathing. During the past year there had been some speech disturbance with gradual interference with breathing. The patient smoked a great deal, and other points in his history suggested malignancy. The surgeon thought he had found a case which would be suitable for laryngectomy. He requested a consultation with me, and, on endoscopic examination, I found a definite stenosis of the trachea, the pressure appearing to be external on the left side; no irregularity nor ulceration of the interior of the larynx or the trachea could be made out. A roentgen-ray examination was requested, which showed a large aneurysm on the left side.

In very old people, who develop hoarseness and dyspnea, cancer is usually first suspected, but laryngoscopy and bronchoscopy may reveal an entirely different condition. The following case illustrates this fact.

CASE 12.—Mrs. T., aged 33, was referred by a physician to determine the cause of shortness of breath, difficult breathing and aphonia. Nothing could be made out in the chest; roentgenograms and the Wassermann test were negative. On bronchoscopic examination, numerous scablike crusts could be made out covering the walls of the trachea and large bronchi. After clearing these off with swabs and suction and making a few applications of argyrol, the dyspnea was relieved and the voice soon returned to normal.

Strictures of the larynx require direct inspection to determine the location, degree and method of treatment to be carried out. Traumatism, postdiphtheritic causes, cancer and tuberculosis are frequent etiologic factors.

CASE 13.—A railway brakeman, thrown from a train, struck his head. No severe cranial injury was apparent at the time, but about two weeks after the accident the patient developed some hoarseness and there was dyspnea on much exertion. No traumatism to the larynx was suspected, in fact, the patient was sent to the hospital with a request for examination of the larynx, with special reference to tuberculosis.

On direct examination, a definite stenosis of the larynx was made out with considerable perichondritis. The pressure was more marked on the left side, and eventually an abscess developed which necessitated a tracheotomy and drainage of the infected area. Later on, dilatations were carried out by direct methods.

This condition was the indirect result of an injury.

CASE 14.—A girl, aged 3 years, had been wearing a tracheotomy tube for several months, following diphtheria. Direct examination with a laryngoscope and bronchoscope showed a great deal of subglottic turgescence, which was responsible for the dyspnea. Cauterization of the granulation tissue by the direct method, followed by dilatation has improved the condition, but the child is still under treatment.

CASE 15.—A girl, aged 7 years, had some dense scars over the trachea, the result of a tracheotomy for diphtheria, performed two months before being sent to me. There was marked stenosis of the larynx; the voice was much affected, and dyspnea was marked. Endoscopic examination showed a great deal of stenosis in the region of the tracheal scar. Under direct vision, laryngeal dilatations were being used at the time of writing.

This case was somewhat similar to Case 14.

CASE 16.—A. S., aged 4 years, was sent to the hospital with a history of having difficulty in swallowing. No history of swallowing a foreign body or corrosives could be obtained from the family. A roentgenogram was negative. On examination with an esophagoscope, a great deal of inflammation of the esophageal mucosa could be made out with stricture formation at the upper third. A gastrostomy was performed and later dilatations were performed, with favorable results. This child evidently had swallowed some corrosive substance unknown to the parents, and a diagnosis could not have been made nor proper treatment have been carried out without endoscopic procedures.

CASE 17.—F. R., colored, aged 3 years, was referred to the hospital to find out the cause of malnutrition and inability to take the necessary amount of food. A roentgenogram was negative, but esophagoscopy demonstrated the presence of multiple strictures, the cause of disturbed deglutition.

In diseases of the esophagus, stricture is one of the most common lesions encountered. In young children the cause is usually due to swallowing some corrosive chemicals or to irritation from foreign bodies, while in adults additional factors in etiology must be considered including malignancy, extrinsic pressure and spasmodic conditions. In most cases a final diagnosis is dependent on esophagoscopy.

CASE 18.—M. A., a girl, aged 5 years, was poorly nourished and had much trouble in swallowing. Fluoroscopy and a roentgenogram demonstrated an apparent spasmodic stricture of the esophagus, which was confirmed by esophageal examination. Under bouginage treatment and proper regulation of diet, the contractions were overcome and the patient was restored to normal health.

Gastro-intestinal disturbances, the result of improper dieting in children, may at times be sufficient to produce spasmodic contractions of the esophageal lumen.

CASE 19.—R. B., a man, aged 59, had been steadily losing weight and was having great difficulty in swallowing solid food. Roentgenogram of the thorax revealed a stricture which was suggestive of carcinoma but not conclusive. With an esophagoscope a typical, irregular, vascular carcinomatous growth could be made out at the lower part of the esophagus. Radium was applied locally and there seemed to be some relief for a while, but in about a year the lumen was occluded, so that a gastrostomy was necessary and in a few months patient died.

CASE 20.—W. M., a boy, aged 4 years, was referred from Tennessee to see if something could be done to relieve an increasing esophageal stenosis. The child had been treated by blind methods of dilatation and was becoming worse progressively. When he arrived at the hospital the condition was serious, and a gastrostomy was necessary to give the patient the much needed nourishment. In a few days an esophagoscopy was made and the examination showed a well formed stricture at the upper third, which was easily dilated by bougies under direct inspection.

CASE 21.—F. J., a man, aged 34, was recently sent to the hospital with symptoms suggesting cardiospasm. Esophagoscopy showed a distinct spasmodic stricture at the cardia which was overcome by dilatation. The patient left the hospital feeling well and was able to eat regular food without difficulty.

CASE 22.—Mrs. M. W., aged 47, complained of being unable to swallow certain solid food. She was very neurotic and globus hystericus was suspected. On esophagoscopy, no stricture was made out and the original diagnosis was confirmed.

In neurotic women, it is often important to know if we are dealing with a true stricture or with an hysterical phenomenon.

CASE 23.—O. F., a seaman, aged 27, drank some stolen whisky, which was later suspected to have contained some corrosive poison. On swallowing, the patient experienced immediate sensations of burning and was sent to the hospital for treatment. Esophagoscopy showed acute esophagitis and later stricture formation which required dilatation.

CASE 24.—K. P., a man, aged 38, was referred from North Carolina to find out the cause of loss of weight and interference with swallowing.

Esophagoscopy showed a spasmodic stricture at the cardia. After several dilatations the patient was able to eat regular meals and when he left the hospital he was steadily gaining in weight.

CASE 25.—R. O., a man, aged 58, complained of vomiting blood-tinged food at times, and was referred for an esophagoscopic examination. He had lost some weight and was developing trouble in swallowing.

Examination and section of a specimen revealed a carcinoma involving the upper part of the esophagus.

CONCLUSIONS

These cases have been presented, not because they are rare, but, on the contrary, because the conditions found are common ones which come up in the average practice. They demonstrate the importance of endoscopic examination and how much practical help can be obtained by such a procedure.

The laryngoscope, bronchoscope and esophagoscope should be more generally used as a diagnostic aid, and the fact should be impressed on the medical profession that endoscopy has a much broader field than merely for foreign body cases. It is surprising how many laryngologists do not even own a direct laryngoscope, and do not attempt the simplest endoscopic examination.

As much skill is required in removing foreign bodies, this field should be left to those who are particularly qualified, but the average specialist should take advantage of the usefulness of peroral endoscopy as an aid to more accurate diagnosis in lesions of the upper air and food passages.

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CHOKED DISKS

IN ASSOCIATION WITH SURGICAL MASTOID DISEASE WITHOUT APPARENT INTRADURAL INVOLVEMENT *

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The association of choked disks with surgical mastoiditis may properly be looked on as an important and suggestive indication of intracranial or intradural extension of the infection. It has been shown, however, that choked disks may occur with surgical mastoiditis without other manifestations of extension. It is imperative, in the proper management of such a case, that its relative significance be recognized by the clinician and surgeon.

Intracranial and intradural extension should be differentiated because of the graver significance of invasion of the brain substance. The otologist learns from experience that parasinous or epidural abscess, serous meningitis, and various localized leptomeningeal changes may be present without interfering with the convalescence, if the case is well managed. The dura manifests great powers of resistance to the spread of infection, but the brain substance does not, at least to the same extent.

It seems permissible to suggest, in patients with surgical mastoiditis found to have choked disks, that careful clinical studies be made, and that untimely surgical interference with the substance of the brain be delayed until reasonably conclusive evidence of intradural invasion has been found.

HISTORICAL DATA

The literature contains numerous articles describing the association of choked disks with surgical mastoid disease. The earliest reference found was that of Barker [1] in his Hunterian lecture in 1889. In dealing with the way in which extension takes place, he speculates with regard to choking of disks in tympanic suppuration when there is no other evidence of intracranial inflammation,

> That the explanation may be found in the fact that the lymphatics leaving the skull by the carotid foramen may have become inflamed from proximity to the tympanic mischief. These lymphatic vessels are derived, as is well known, from

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* Read before the American Otological Society, Washington, D. C., May 4-6, 1925.

* From the section on Otolaryngology and Rhinology, and the section on Ophthalmology, Mayo Clinic.

1. Barker, A. E. J.: Intracranial Inflammations Starting in the Temporal Bones; Their Complications and Treatment. Hunterian Lectures. London, H. K. Lewis, 1890, pp. 72.

affluents following the several branches of the internal carotid artery, and among these the ophthalmic. Now it is conceivable that inflammation of the lymphatic trunks in the carotid canal and their possible obliteration might seriously retard the course of the fluid in the absorbents of the optic nerve; or a thrombosis might start in the inflamed lymphatic trunks and extend backward to the lymph spaces about the ophthalmic artery, so producing engorgement of the lymphatics and venous circulation of the fundus oculi.

Again, is it not possible that damage to the carotid plexus of the sympathetic from the intradural inflammation might produce vasomoter disturbances in the optic nerve and fundus independent of any brain disease?

Lunn,[2] in 1899, reported two cases of double optic neuritis with disease of the mastoid cells uncomplicated by intracranial disease. A boy of eleven years, with a history of aural discharge following influenza, was found to have, among other symptoms and signs, optic neuritis. At operation a parasinous abscess was found. Following operation the convalescence was satisfactory, and the fundi were normal two months later.

A girl, aged 14 years, giving a seven years' history of aural disease, was found to have the optic disks swollen, more especially on the right side. Three days after operation the swelling began to disappear.

Barker later reported two cases of choked disk associated with a parasinous abscess. One patient recovered in three months. The other had more intense swelling after operation, but gradually recovered. Barker suggests that she may have had an intradural complication. He said, "If it should be proven hereafter by postmortem evidence that the presence of purulent inflammation in the sulcus lateralis (which certainly existed in the last case and probably in the first) is capable of producing optic neuritis in the absence of meningitis or cerebritis, we shall have secured a very valuable diagnostic symptom for a class of affection on which, at the present time, it is difficult to come to a conclusion."

Lunn, in his discussion, makes the same suggestion, so it is apparent that these observers felt that parasinous abscess had a bearing on the production of choked disks.

After a study of 100 consecutive cases of middle ear and mastoid disease, Barr and Rowan [3] came to the conclusion that vascular changes in the fundus oculi are not uncommon, as in six of them optic neuritis was found, and in twenty-one, abnormal vascular changes. In all cases in which the fundus changes were found, the ear and mastoid disease

2. Lunn, J. R.: Two Cases of Double Optic Neuritis, with Disease of the Mastoid Cells, Without Evidence of Intracranial Disease; Recovery, West London M. J. **4**:124-127, 1899.

3. Barr, J. S., and Rowan, John: An Investigation into the Frequency and Significance of Optic Neuritis and other Vascular Changes in the Retinae of Patients Suffering from Purulent Diseases of the Middle Ear, Brit. M. J. **2**:1480-1482. 1907.

was of a serious character, so that the fundus change may be regarded as a danger signal and an indication for careful observation of the patient.

Conant and McKeown [4] reported a case of persistent papilledema associated with mastoiditis, which gradually subsided three months after operation. There was good vision at all times.

Espenschiea,[5] in 1904, reported one case of mastoiditis and one of parasinous abscess, each with optic neuritis or choked disk. He made no distinction between choked disk and optic neuritis.

Ruttin,[6] in 1911, reported cases of choked disks due to sinus thrombosis and brain abscess, and asserted that meningitis could not produce choked disks, but would cause optic neuritis. All his patients showed evidence of pressure on the superior and inferior petrosal sinuses.

Ballance [7] says, "It is important to remember that very severe general symptoms with vertigo, vomiting and optic neuritis may be caused by retention of pus within the temporal bone before any gross intracranial lesion has occurred, and complete recovery may then take place on operation limited to the bone."

Haskin [8] is inclined to believe with Gruening, whom he quotes, that the explanation of the association of choked disks with mastoid disease lies in disturbance of the sympathetic nerves. He thus reverts to one of Barker's explanations. To Gruening this is more satisfactory than the chemotaxis theory of Leber, or the theory of hydrostatic pressure.

Buckley [9] reported a case in 1922. In 1923, von Hippel [10] stated that choked disks could develop after successful mastoid operations without other evidence of intracranial affection. Eagleton [11] states that papilledema may result from some changes in the composition of cerebrospinal fluid, due to infection in the apex of the temporal bone, associated with mastoiditis.

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4. Conant, E. F., and McKeown, E. E.: Persistent Papilledema Perhaps Connected with Mastoiditis, Ophth. Rec. **2**:282-283, 1912.

5. Espenschiea: Ein Beitrag zur Frage der Beziehungen zwischen Caries des Felsenbeins und Neuritis optica, Arch. f. Ohrenh. **63**:1-11, 1904.

6. Ruttin, E. L.: Ueber Stauungspapille bei otogenen Komplikationen. Verhandl. d. deutsch. otol. Gesellsch. **20**:369-376, 1911.

7. Ballance, C. A., and Green, C. D.: Surgery of the Temporal Bone, London, The Macmillan Company **2**:406, 1919.

8. Haskin, W. H.: Ocular Manifestations in Nasal and Aural Diseases Which Probably Indicate Involvement of the Sympathetic Nervous System, Tr. Am. Otol. Soc. **46-48**:144-172, 1913-1915.

9. Buckley, J. H.: Choked Disks from Parasinous Abscess: Sinus Normal, South. M. J. **15**:762-763, 1922.

10. Hippel, E. V.: Die Krankheiten der Sehnerven. Graefe-Saemisch Handbuch **7**:64, 1923.

11. Eagleton, W. P.: Brain Abscess, Its Surgical Pathology and Operative Technique, New York, The Macmillan Company, p. 173.

ILLUSTRATIVE CASES

The four cases of choked disk presented showed somewhat different types of pathologic change. The first patient was found to have a parasinous abscess, later complicated by toxic nephritis; in the second case little pathologic change was found in the mastoid cells, and later exploration of the brain revealed no abscess; in the third case a large cholesteatoma was exerting so much pressure on the sigmoid and dura over the cerebellum that the dura was found definitely indented; in the fourth case pachymeningitis extended over the petrous portion to the anterior surface, and a parasinous abscess was found. Other cases associated with definite intradural disease or sinus thrombosis are excluded.

CASE 1.—A woman, aged 20, came to the clinic because of discharge from the right ear, mastoid pains, chills and fever. The trouble began four weeks previously with severe pain in the right ear following an upper respiratory infection. Five days later the ear drum ruptured spontaneously.

Examination revealed definite right surgical mastoiditis, pyelonephritis, and a choked disk of 3 diopters with a fresh hemorrhage. Neurologic examination showed no abnormality. Operation revealed a parasinous abscess without obstruction of the sinus. The leukocytes ranged between 6,200 and 13,800. The blood culture was negative. The urinary findings were characteristic of pyelonephritis which proved resistant to treatment for a long period. After three months the fundi oculi were normal. (The visual fields were not examined in this case.)

CASE 2.—A girl, aged 14, came to the clinic in June, 1923, complaining of weakness and a rise in temperature in the afternoons, following otitis media contracted during measles. The symptoms had been present for about a month. During this time an occasional chill had occurred, with a temperature elevation to 105 F.; moderate pain in the right temporal region had been felt for a few days.

Examination showed a slight discharge in the right external auditory canal, but there was no mastoid tenderness. The cervical glands in the upper triangle were enlarged and somewhat tender. Laboratory examinations, including blood culture and investigation of the spinal fluid, were quite negative. Examination of the fundi showed beginning choked disk but the fields were normal. Exploration of the mastoid revealed infected granulation in the mastoid cells, but the dura and lateral sinus were normal. Pain in the right temporal region was complained of irregularly. The swelling of the disks increased. The cervical adenitis increased, and weakness in the right facial nerve became manifest. After twenty-four days the brain was explored with negative findings. All symptoms and signs gradually disappeared.

CASE 3.—A woman, aged 20, came to the clinic complaining of a discharging left ear and a feeling of pressure in her head. Thirteen years before, following measles, she had had a discharge from the left ear, and mastoidectomy had been performed shortly after the onset of the trouble. She had had no further trouble with the ear until one year before coming to the clinic when the ear discharged again after she had been swimming. The trouble cleared up under treatment in about a month. Four months later, she had had a sudden attack of dizziness and vomiting. Objects seemed to move to the right. The attack lasted for about three days. The same ear began discharging and continued to do so until the time of admission. The patient had a sensation of pressure on the left side of her head with blurring of vision.

On examination, the patient was in excellent physical condition; all the laboratory findings were negative. The left ear and mastoid showed the effect of a former mastoid operation. The ear was discharging foul pus containing

cholesterin crystals, and the mastoid was somewhat tender to pressure. Neurologic examination revealed no objective findings, but the general picture was suggestive of a cerebellar lesion. The vision was 6/6 in each eye. The external examination was negative. The media were clear. The fundi showed bilateral choked disks of 3 to 4 diopters, with numerous exudates and hemorrhages on the disks. The arteries and veins were tortuous. The perimetric fields were normal both for form and colors, but the blind spots were markedly enlarged.

During hospital observation an acute exacerbation developed in the left mastoid. The mastoid was opened and a large round cholesteatoma was found to be definitely pressing and indenting the dura over the cerebellum. The dura showed marked pachymeningitis, but no break in its continuity could be found. The dura of the middle and posterior fossae were purposely uncovered. The labyrinth capsule was negative on inspection. The healing of the wound was satisfactory. Following operation, the choking of the disks receded gradually and the hemorrhages and exudates disappeared. The perimetric fields remained normal, while the enlarged blind spots diminished in size until nearly normal. When the patient was dismissed from observation, there was still a slight residual edema of each disk without any hemorrhage or exudates. The vision remained normal throughout the entire period of observation.

CASE 4.—A man, aged 36, came to the clinic because of headache, discharging right ear and hoarseness. There was a history of otitis during boyhood. The present ear trouble had begun six months before, when he had had a severe right-sided earache, lasting one day. At that time he began to feel pain in the outer angle of the right orbit and temporal region. He complained of diplopia at a distance. About two months previous to registration the right ear had begun to discharge. The orbital pain, diplopia, hoarseness, and aural discharge were still present at the time the patient came to the clinic.

Findings in the nose and throat were negative with the exception of a small whitish area on the right vocal cord of no significance. The right ear contained considerable thick discharge. The wall of the canal drooped and showed a few granulations in the middle ear. The left membrana tympani was retracted. Roentgenograms of the mastoids showed a few cells filled with air, but general cloudiness.

Dec. 30, 1924, the vision was normal in each eye. The examination of the external eye was negative, except for questionable conjugate weakness to the right. The diplopia could not be elicited with the red glass, but a definite divergent insufficiency was found. The media were clear. The fundi showed edema beginning in both disks, especially in the upper nasal quadrants. There were no hemorrhages or exudates. The perimetric fields were normal both for form and colors, but the blind spots were moderately enlarged.

Complete general and neurologic examinations revealed no other abnormality. A diagnosis of chronic mastoiditis was made with the probability of a low-grade meningitis and the possibility of a brain abscess. The diplopia suggested a Gradenigo syndrome. It was decided to operate on the mastoid.

When the cortex was removed, pus welled up through a small opening, which when cultured showed a staphylococcus. On the removal of the cortex posteriorly a parasinous abscess was found. The dura showed a well developed pachymeningitis. In Trautman's triangle, there were many small cells extending along the petrous portion of the temporal bone, and the dura in this region was red. The dura was carefully uncovered in all directions to the limit of the disease process. The wound was packed with iodoform gauze.

Following the operation, the edema of the right disk subsided completely, while a fresh hemorrhage appeared above the left disk which still showed slight residual edema. One week later, the hemorrhage disappeared and the only residuum was a slight blurring of the upper nasal margin of the left disk. The blind spots returned to normal size. The vision remained normal throughout the entire period of observation. On Feb. 2, 1925, the wound was healed, and the patient could hear a whisper with the right ear.

COMMENT

In Cases 3 and 4 the patients were sent to the clinic by their physicians because of the conviction that the choked disks clearly indicated some intradural complication. The incidence of choked disk in cases of surgical mastoiditis without intradural extension is low, but their occurrence under such circumstances has been established. It is true that it has not been proved that there was no intradural extension, but there was no manifestation of it, and recovery after operation on the mastoid constitutes reasonable proof of its absence.

In Case 1, the pyelitis was a complication, but probably not a factor in the fundus change, because the condition was definitely a choked disk and not an optic neuritis. In this case the acute parasinous abscess produced general symptoms.

In Case 4, the pseudo-Gradenigo syndrome could be explained by the extension of disease to the anterior surface of the petrous portion through the cellulae petrosae. Either eye followed objects well enough, but, acting together, there was a slight conjugate weakness to the right. No diplopia was elicited with red glass, showing that there was no paralysis of the sixth nerve. The diplopia complained of could be explained by the insufficient divergence. After operation, these symptoms cleared rapidly. There was a definite parasinous abscess and definite change in the dura over Trautman's triangle.

In Case 3 the cholesteatoma was causing notable pressure over Trautman's triangle, and the dura showed definite thickening and pachymeningitis.

These findings agree with those in the previously reported cases, and demonstrate that choked disk may be associated with pathologic change in the sulcus lateralis. The significance so far as the mechanism of choked disk is concerned is, however, not determined. The expectant observation following the operation on the mastoid in Case 3 shows the value of declining unwarranted or misdirected exploration, when pathologic change sufficient to explain the findings is encountered at the mastoid operation.

In the Mayo Clinic, the term "optic neuritis" is used to describe only an inflammation of the optic nerve at the disk, which is characterized by all the cardinal signs of any inflammation, with perhaps the exception of pain. The expression choked disk is used to describe a pressure syndrome in which the return flow of fluid from the posterior portion of the eyeball is impeded or stopped, regardless of the cause, resulting in a passive damming back of the fluid in the optic nerve. This is in accord with Behr,[12] and seems to apply more readily to clinical conditions than any other stated theory.

12. Behr, Carl: Zur Entstehung der Stauungspapille, Arch. f. Ophth. **101**:165-209, 1920.

Ophthalmoscopically, the four cases reported here are interesting from a diagnostic standpoint. All the patients had normal visual acuity in each eye. All had typical bilateral choked disks with swelling varying from one to four diopters. The perimetric fields were normal both for form and color. The blind spots were enlarged. The ocular findings were of no clinical value so far as a definite localization was concerned, since these ocular changes could be produced by either an extradural or an intradural lesion. Even in proved abscesses of the temporal lobe, defects in the perimetric field are not common, and normal fields do not exclude the possibility of abscess in this situation. The presence of bilateral choked disks without any other neurologic change is very significant, but too hasty intracranial exploration is to be discouraged.

SUMMARY AND CONCLUSIONS

The four patients with choked disk associated with surgical mastoiditis recovered completely. There was no conclusive evidence of intradural extension, although it could not be definitely excluded. Three patients were found to show intracranial involvement in the form of a parasinous abscess; the other showed a pachymeningitis and a large cholesteatoma formation pressing on the sinus and cerebellum. One patient was subjected to intradural exploration without result.

The mechanism of choked disks in such cases is a moot question. Intradural exploration without more conclusive evidence of intradural disease is not warranted. The fundi oculi should be examined in all surgical mastoid cases. The incidence of choked disks in surgical mastoiditis without intradural extension is low, but sufficiently frequent to be considered in the differential diagnosis.

BACTEREMIA DUE TO TONSILLECTOMY COMPLICATED BY MASTOIDITIS

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I was called to the hospital to examine a patient who had been brought from a neighboring town, and whom I had never seen before.

I knew nothing of her previous condition except what had been told me in a brief conversation over the telephone by the attending physician.

REPORT OF CASE

History.—Two weeks before the patient's present illness, tonsillectomy had been performed (ether), at which time the hemorrhage was unusually profuse and difficult to control, requiring the placing of a sponge in one fossa for several hours. After her return home she failed to recover in a normal manner, being slow in regaining her strength and showing "a continuous high fever" (no figures obtainable). A week later, that is, seven days before I saw her and a week after the tonsillectomy, she developed an earache and the drum ruptured "in an hour or two" with immediate relief from pain. Such attacks had been occurring every few months in the last two years, but she always appeared to recover from them without any complication after the ear had discharged for "about a week." In the two days preceding my examination she had had two severe chills, high fever and a sweat, each time "so heavy as to wet the mattress;" in fact, four hours before I saw her, she had had this same group of symptoms. This was the history on which I had to depend in forming my opinion, which was at first influenced by the clinical picture presented by a patient having every symptom of a mastoiditis complicated by a sinus thrombosis—if the history was to be accepted without reserve.

Examination.—The patient was a highly apprehensive, neurotic girl, aged 16 years, apparently very toxic, with a temperature of 102.4 F., and a middle ear discharge of moderate amount, though the discharge was thick and the deafness marked on the affected side. There was, however, absolutely no local tenderness, and, so far as could be made out, no sagging of the posterosuperior canal wall; yet an opening of the mastoid cells was indicated from the history, especially that part which suggested previous mastoid attacks, or a "latent" mastoiditis as it is sometimes termed. However, as the patient had had practically no sleep for three nights and was prostrated by fright, her illness and the jarring of the seven mile trip by automobile, I decided to operate after she had been strengthened by sleep induced by morphin.

At operation, nine hours later (10:00 a. m.), I found that the patient had an acute exacerbation of chronic mastoiditis. A densely sclerotic cortex, obliteration of the pneumatic cells and substitution of hard bone, occasional islands of carious bone and granulations were present. The antrum was filled with a soft, pulpy material and brittle pieces of carious bone. Having in mind the chills and sweats, I uncovered the sinus, removing a small window from the bony plate, but I found it apparently healthy. It was improbable that a mild otorrhea of six days' duration could result in a thrombosis or phlebitis without any evidence of the condition around the sinus. At the time I attributed the septic symptoms to the perisinous pus which I had released in uncovering the sinus plate. At the time of this operation a specimen of the patient's blood was secured and cultivated. Her recovery during the day from the operation of the morning was encouraging. She appeared to be comfortable, and the temperature fell to 99.5 F. The next

morning, however, I found that late the night before she had had a prolonged chill, sweat and a rise in temperature to 104.2 F., following a fall to 97.3 F., and the blood culture showed streptococci. Thus, I concluded that the condition was a phlebitis of the sigmoid sinus, if not a thrombosis, and I operated two hours later. Again nothing was found, even when the membranous wall of the sinus was opened; there was no thickening, nor the slightest obstruction in the flow of blood from each end of the sinus. However, as a bacteremia not only follows clot formation, but also precedes and actually causes a thrombosis, the internal jugular vein was ligated in two places at the level of the cricoid cartilage, but was not cut.

Six hours after the second operation the left knee swelled greatly and became intensely painful, again suggesting a thrombophlebitis with a metastasis. Several days later, the knee joint was aspirated without revealing any excess fluid, and a culture from this was sterile. A subsequent roentgenogram taken a month later showed destruction of the cartilage and articular surfaces of the bones, probably of tuberculous origin. For two days the characteristic "church steeple" temperature prevailed, subnormal in the morning and above normal in the evening (97.2 to 104.4 F.), though unaccompanied by chills or sweat. The hemoglobin was 40 per cent. and the leukocytes fluctuated between 11,000 and 18,000, never lower and never higher, while repeated blood cultures, taken at two-day intervals after the first positive one, were all sterile. The latter condition might have led to the erroneous conclusion that the ligation had cut off the source of the systemic infection (that is, the mastoid), had I not known otherwise from my exploration of that process and the sigmoid sinus. The anemia was almost certainly due to the loss of blood at the tonsillectomy, aggravated by the toxemia of the chronic mastoiditis; in any event, it markedly interfered with the healing process of the mastoid wound. The granulations for ten days were flabby, pale and exuberant, being bathed in a profuse, thick, creamy purulent secretion, and numerous small sequestrums came away at dressing from time to time. Two transfusions (from 450 and 400 c.c.) were made to correct these conditions and seemed to be successful from the beginning, while the use of an autogenous vaccine (*Staphylococcus albus*) and the free painting of the wound with tincture of iodin materially assisted in closing the wound, after the pus and granulations diminished. The latter I had to cut away three times with scissors and later with silver nitrate.

Ten days after the ligation the patient complained bitterly of pain in the ear, and I found that the canal was full of heavy pus, which, however, did not originate in the middle ear, but had burrowed underneath the cartilaginous canal from the general mastoid wound, separating it from the bony canal and setting up an acute chondritis. This was the first of numerous complications that disturbed both the patient and myself, and was followed by an acute empyema of both antrums which proved most stubborn on account of the patient's debilitated condition, requiring two weeks' unceasing care and irrigation two or three times a day before it yielded to treatment.

While confidence in my own opinion was a little shaken by the recurrence of the septic symptoms after the mastoid exenteration, I felt that the source of the bacteremia could not be the mastoid process. The proof of my contention seemed absolute since the blood showed only the nonhemolytic streptococcus, while cultures from the mastoid and middle ear discharge, made repeatedly, always showed *Staphylococcus albus* in pure culture. Undoubtedly the tonsillectomy threw a large number of the former organisms into the circulation, while the patient was particularly nonresistant, and caused the bacteremia with its stormy, septic symptoms. Of course, it has been known for some time that a bacteremia can originate from infected tonsil crypts, even without the depressing effect of an operation or the lowered vitality associated with anemia and chronic mastoiditis. Moreover, the bacteremia would almost certainly have disappeared without any jugular ligation in this instance; yet, on the other hand, there was active mastoid disease, necessitating a mastoidectomy. In fact, it was fortunate that the patient did have symptoms that led to such an operation before it was too late, as a deep-

seated mastoid infection, covered with a shell of ivory-like bone, is the most dangerous type, for it seldom gives local warning signs, yet is in the most dangerous place and is of the type that demands relief. The infective material is so placed that it cannot escape externally and must of necessity burrow into vital structures, often going fatally far before saving measures can be taken.

COMMENT

This case presents every classical symptom of a sinus thrombosis in pronounced degree (temperature range of 97.2 to 104.4 F., chills, sweats, otorrhea, history of recurrent earache, bacteremia), and yet there was no such condition. On the other hand, a mastoidectomy was definitely indicated and justified in the light of the pathology found in the bone at operation.

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SPONTANEOUS NYSTAGMUS

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A consideration of the question of spontaneous nystagmus usually presents itself as something of great mystery, as a symptom of such complexity that its significance thereby becomes considerably lessened. The presence of spontaneous nystagmus is not heralded as an additional sign to the other manifestations of some syndrome. An observation for nystagmus is not made at all, or, one might say, only with reluctance for, in general, it is not thought to add any definite clues to the location or nature of the pathologic process.

That these impressions concerning the subject are untenable we may readily surmise when we encounter nystagmus as a prime feature of a true labyrinthine disease, in conjunction with vertigo and diminished hearing consequent to otitis media. Under similar circumstances, its absence would not permit the diagnosis of labyrinthine inflammation on first examination. Likewise spontaneous nystagmus, in addition to other signs and symptoms, may suggest the extent of the disease, and the character of the nystagmus itself permits certain analysis aiding in the determination of the causal factor. That nystagmus possesses per se, that is, taken as a single sign, enough importance to encourage search for it and to analyze it, I shall attempt to demonstrate.

DEFINITION OF NYSTAGMUS

It is not difficult to define nystagmus as it is seen when produced by a labyrinthine disturbance; however, to enable us to recognize it more readily and to differentiate it from other simulating ocular movements, a short explanation by a contrast of two large groups will be given. This already suggests that we may divide all nystagmus into labyrinthine and nonlabyrinthine, or vestibular and nonvestibular.

Fraser [1] defines vestibular nystagmus as a "rhythmic, associated movement of the eyes, consisting of a slow movement of the eyes in one direction followed by a quick return in the opposite direction." The nonvestibular nystagmus embraces chiefly an oscillatory or pendulous movement of both eyes, although, as we shall see, other movements are included in this group.

CENTRAL VESTIBULAR NYSTAGMUS

Its most common occurrence is in encephalitis and meningitis, acute and chronic, and in multiple sclerosis. Attempt at localization in these conditions is of no significance because the treatment is the same what-

1. Turner and Fraser: Diseases of the Nose, Throat and Ear. New York: William Wood & Co., 1925, p. 260.

ever region is involved. Syringobulbia with involvement of the floor of the fourth ventricle, within which lies the fasciculus longitudinalis posterior, may in its incipiency produce only central vestibular nystagmus. Such a case has been reported by Brunner.[2] The spontaneous nystagmus was unquestionably central in origin and due to involvement of some part of the vestibular system. Later, a vocal cord palsy occurred on the same side as the direction of the nystagmus. This additional symptom permitted an exact localization of the pathology. There was an involvement of the floor of the fourth ventricle, with the posterior longitudinal bundle and the tenth nucleus affected. Subsequent progress of the case showed that syringobulbia existed.

Multiple sclerosis, it might be argued, could be responsible for the same symptoms. That is true, and differentiation would be difficult. Fremel [3] recites a similar case. The spontaneous nystagmus was central, was associated with vertigo and in addition there was unilateral vocal

NYSTAGMUS

Vestibular		Nonvestibular
Central	Peripheral	1. Optical nystagmus (*a*) Visual (*b*) Pseudonystagmus (*c*) Fixation (*d*) Experimental 2. Vertical nystagmus 3. Retractile 4. Spasmus nutans 5. Latent nystagmus.
A nystagmus produced by (*a*) an organic disease of the peripheral sense organ, or by (*b*) an organic or functional disease of the central vestibular system (Brunner, Hans, in Alexander, Marburg and Brunner: Neurology of Ear, Wien, Urban & Schwarzenberg, **1**:939, 1924).		

Convergence spasm.
Conjugate deviation.

cord paralysis. The cord paralysis was complete, hence not due to multiple sclerosis; the laryngeal nerve suffered at a more vulnerable point in the neck from a thyroid malignancy. Later, however, transient ocular muscle palsies in this case assisted in identifying the nystagmus with multiple sclerosis.

In the vast category of tumors, abscesses, tubercles, hemorrhages, the presence of nystagmus would point toward a localization in the posterior longitudinal bundle; in the cerebellum, direct involvement or through pressure; in the medulla, that portion of the vestibular tract above the eighth nucleus; sometimes a small frontal lobe tumor will produce nystagmus and other symptoms pointing to a process in the

2. Brunner, H.: Wien. klin. Wchnschr., 1922. Demetriades and Mayer: Monatschr. f. Ohrenh. **6**:13, 1922.

3. Fremel, H.: Wien. Klin. Wchnschr., 1923.

cerebellum on the opposite side. This confusion has been attributed to the crossed fibers connecting the frontal lobe and the cerebellum, namely, the frontopontinecerebellar tract.

Diagnosis of tumor, abscess, tubercle or hemorrhage and their localization depends, of course, on the nature of the concomitant symptoms; that is, cranial nerve involvement, peripheral sensory disturbances and aberrations in motor function.

Nystagmus after Trauma to the Head: If nystagmus is present, usually the trauma may be established as the causal factor. However, a multiple sclerosis, for example, may have anteceded the trauma and could be responsible for the present nystagmus and giddiness. The patient too may claim compensation, attributing his disagreeable condition to the trauma. The limits of this paper will not permit a differential diagnosis between traumatic manifestations, traumatic neurosis and other cranial conditions, but proposes only to suggest the possibilities of a coincident head trauma and brain disease.

When of central origin, vestibular nystagmus by contrast with peripheral nystagmus possesses the following characteristics: In central nystagmus the nystagmus is horizontal; in peripheral, horizontal-rotatory. In nystagmus of peripheral origin the vertigo is always proportional to the intensity of the spontaneous nystagmus. This is not necessarily true when a central disturbance is present. A central process may lead to a persistent nystagmus; a peripheral process does not produce a nystagmus of over two to three weeks' duration. The relation to the falling reaction—Romberg test—is also of interest and value. Central disease produces a falling that is not dependent on the direction of the nystagmus. In peripheral disease the Romberg sign is in the direction of the slow component and the staggering is dependent on the position of the head. For example, a patient has a spontaneous nystagmus to the right, the Romberg sign is to the left. The disease may be central or peripheral. Now the relation between the direction of the staggering and the position of the head is tested. The patient, say, does not fall toward the slow component of the nystagmus on altering the position of his head, so we may state that the condition is not peripheral.

PERIPHERAL NYSTAGMUS

A labyrinthine condition produces a horizontal-rotatory nystagmus to the healthy side; the vertigo being in direct relation with the intensity of the nystagmus. There is no optical inversion of this spontaneous nystagmus (this procedure will be mentioned in greater detail later). Rombergism is toward the slow component of the nystagmus and is dependent on the head position. Additional features supporting the labyrinth condition are a chronic suppurative ear with a fistula symptom,

or an acute exacerbation with diminished hearing. The syndrome often misnamed Ménière's disease is characterized by a similar nystagmus and vertigo, the middle ear symptoms, of course, are not characteristic features. The syndrome is due to a labyrinthine involvement in leukemia, syphilis, arteriosclerosis, chronic adhesive process, etc.

Peripheral vestibular nystagmus may also be due to a neuritis of the eighth nerve, a rare condition. In this category belongs also the polyneuritis cerebralis minieriformis of Frankl-Hochwart, an auspicious terminology, meaning a progressive neuritis involving in turn several cranial nerves, chronic in its course, receding entirely with the exception of a permanent involvement of one of the nerves. Other labyrinthine conditions may be grouped under intoxications and otosclerosis. The intoxications most commonly are from arsenic, veronal, phenobarbital, botulism, mumps and diphtheria. A nystagmus to the involved side can be elicited in a chronic adhesive process by vigorously shaking the head, the patient looking toward the affected ear. This nystagmus is quite a constant feature, although it cannot be elicited more than once or twice.

Nonlabyrinthine nystagmus is only characteristic in that the two components are not alternately slow and rapid, but the movement of the eyes is undulatory or pendulous. The form is horizontal, vertical, rotatory, or a combination of these. Often the direction cannot be definitely determined when the two components are of similar rapidity. Unlike labyrinthine nystagmus, therefore, the nystagmus may not become more marked when looking toward the quicker component (Alexander).

The most common type under this heading is the optical or visual nystagmus, due chiefly to a congenital pigment disease or cicatrization of the cornea before the child has learned to fixate. For the sake of convenience, coal miners' nystagmus may be regarded as an optical phenomenon.

When an exact, routine search for nystagmus is conducted, it will be noticed that over 50 per cent. of persons, on directing the eyes to the extreme left or right, manifest a couple of short jerks. This is not regarded as significant, although quite a constant occurrence in neurasthenia and epilepsy. This is known as focusing or pseudonystagmus.

Fixation nystagmus is another phenomenon, observed microscopically only, and attributed to excursions of the central visual ray on the various cells of the macula. If this nystagmus becomes macroscopic it indicates disease, that is, retinitis pigmentosa, chorioiditis, albinism, macula corneae after a blenorrhea neonatorum. The before-mentioned types of nystagmus are not accompanied by vertigo.

A horizontal nystagmus, nonvestibular in type, may be produced experimentally. Commonly known as railroad nystagmus, it may be

produced by revolving before the patient a white ring on which are regularly arranged black bands.[4] The nystagmus occurs in the opposite direction to the revolutions of the ring. If we place a case with a definitely known labyrinthine nystagmus—such as a patient with labyrinthitis—before the revolving ring, the labyrinthine nystagmus will be suppressed and an experimental optical nystagmus will be produced in the direction opposite to the revolutions of the ring. If, however, this ring experiment fails to suppress the spontaneous nystagmus of the patient, it can be definitely stated that his spontaneous nystagmus is nonvestibular.

A vertical nystagmus is usually nonvestibular, however, when associated with vertigo and a central vestibular lesion must be suspected. Tumor, hemorrhage or encephalitis involving the midbrain will give a vertical nystagmus. Similarly, a tumor of the anterior cerebellum with pressure on the midbrain as well as rupture of an abscess (Ruttin),[5] or hemorrhage into the brain ventricle may be accompanied by vertical nystagmus.

A very rare type is the retractile nystagmus when the seat of the disease is in the neighborhood of the aqueduct of Sylvius. The bulbus oculi has a pulsatory movement, which is not synchronous with cardiac function.

New-born infants may have a spontaneous horizontal nystagmus accompanied by a "nystagmus" of the head. This rhythmic head movement may exist alone. Congenital syphilis and idiocy have been held responsible for this interesting phenomenon, but spasmus nutans,[6] as the condition is termed, is now regarded as a spasmophilic manifestation. This, however, does not add to our knowledge of the pathology or etiology of the condition.

A peculiar nystagmus of the nonlabyrinthine type is the so-called latent nystagmus—really an unusual observation. It may be encountered under circumstances something like the following. A recruit is drafted into the infantry, his vision being nearly normal. His record at the target proves to be bad, the soldier claiming he cannot see the target distinctly. He is accused of malingering. As a matter of fact he has a latent nystagmus which becomes manifest when one eye is closed as in aiming. The explanation for latent nystagmus has not been suggested. That it is an ocular nystagmus can be concluded from the fact that some patients who already possess a spontaneous optical nystagmus, will develop a nystagmus of still greater intensity if one eye is blindfolded.

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4. Brunner, Hans: Ztschr. f. Hals-, Nasen- u. Ohrenh. **3**:16, Klin. Monatsbl. f. Augenh. (June) 1922.
5. Ruttin: Diseases of the Labyrinth, Josef Safář, Wien, 1922, p. 85.
6. Fisher, J.: Wien. klin. Wchnschr., 1923.

There are two phenomena, although they cannot be strictly classed with nystagmus, that nevertheless need to be mentioned in a discussion of this subject. These are convergence spasm and conjugate deviation.

CONVERGENCE SPASM AND CONJUGATE DEVIATION

Convergence spasm of the eyes occurs spontaneously when attempting to fix the eyes on an object either near or distant. Sometimes, when in the presence of a circumscribed labyrinthitis, a fistula symptom test is performed, convergence of one or both eyes results instead of the expected nystagmus on compression or aspiration. This is quite a characteristic sign of true hysteria.[7] The same patient may have a convergence spasm on application of pressure on the ovaries.

Conjugate deviation, that is, the condition in which both eyes are deviated in the same direction, is due to paralysis or spasm of one of the parallel momements.[8] The lesion is either cortical or pontile. Conditions of the cerebral cortex, of the subcortical association paths, or of the tracts connecting the cortex with the third, fourth and sixth nuclei, compose the first group, and, as will be noted, are more or less situated in the middle cranial fossa. A simple example is the deviation occurring in a terminal meningitis (middle fossa involved). When the pons is the site of the lesion, other concomitant symptoms of posterior cranial fossa involvement will be in evidence. Cerebellar abscess (with pressure on the pons) often produces a conjugate deviation of the eyes to the side opposite to the abscess.

SUMMARY

The foregoing, cursory discussion is an attempt to assist me in analyzing spontaneous nystagmus. When an associated movement of both eyes shows a quick and slow component possessing a regularity of rhythm, with the nystagmus increasing in intensity when the patient looks in the direction of the quick component, we may assume the nystagmus to be vestibular. Concomitant ear symptoms, or symptoms arising from involvement or compression of certain brain centers, assist in differentiating a peripheral and central nystagmus. Eye movements possessing no regularity of rhythm, whose intensity does not increase when looking toward the quicker component, and which are not associated with subjective vertigo, may be assumed to be nonvestibular.

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7. Leidler, Rudolf: University Lectures, Vienna, 1923-1924.
8. Fuch's Textbook of Ophthalmology, p. 338.

PAPILLEDEMA OF OTITIC ORIGIN *

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Valuable data frequently become lost in our hospital records simply because no operator sees enough similar cases to draw worth while conclusions. This fact so impressed me that, after following a few unusual cases in my own service, I went over the aural records of the Massachusetts Eye and Ear Infirmary for the last thirty years and collected the following references on papilledema. These data are of especial value, as they are derived from cases in which the patients not only have been under the care of many aural surgeons but have also been examined by various members of the ophthalmic staff.

In brain abscess, meningitis and lateral sinus infections, it is imperative that a correct diagnosis should be made as early as possible, and experience has demonstrated that important help can be obtained by frequent examinations of the eyegrounds, in spite of the fact that absence of ocular symptoms does not exclude intracranial involvement.

While it is true that papilledema is a variable accompaniment to increased intracranial pressure, it is, nevertheless, a valuable guide to the necessity for surgical intervention.

The nomenclature is confusing, especially when attempting to distinguish between optic neuritis and early papilledema. Eagleton [1] well says:

> Clinically, it is seldom possible to differentiate between an optic neuritis and a papilledema. . . . The nerve head manifestations of brain abscess usually are a combination of both. . . . The causes giving rise to them are not thoroughly understood.

In this study the word "papilledema" is used in a broad sense, and designates all those changes of the optic nerve due to increased intracranial pressure which are marked enough to be clearly recognized. It does not include dilatation of the retinal vessels as this is not a condition necessarily indicative of optic nerve edema. Many times it is only a matter of the personal equation of the examiner.

CLASSIFICATION

1. Marked papilledema, that is, of 2 diopters or over, usually with hemorrhages.

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* Read before the Section on Laryngology, Otology and Rhinology at the Seventy-Sixth Annual Session of the American Medical Association, Atlantic City, May, 1925.

1. Eagleton, Wells P.: Brain Abscess, New York, The Macmillan Company, 1922, p. 168.

2. Slight or early papilledema, that is, under 2 diopters yet with some elevation of the disk.

3. Blurring of the disk margins, often designated as optic neuritis.

(These three classes all show some optic nerve changes and in this paper are included under papilledema.)

4. Dilatation of the retinal veins, that is, enough change to keep them out of the normal.

5. Normal.

The first three subdivisions are practically identical with those that Bordley [2] attributes to Marcus Gunn, although arranged in the reverse order. In his first subdivision, which corresponds to my third, he states: "The first stage is that of increased redness and blurring of the superior and inferior disk margins."

In his second stage, which corresponds to my second, there is a "beginning filling of the cup with blurring of the temporal margin and a tendency of the edema to spread into the retina."

In his third, which corresponds to my first stage, there is a "decided increase in edema and elevation of the nerve head associated with the forming of striae between the disk and macula and retinal hemorrhages."

In his fourth stage, there is simply an increase in the edema and number of hemorrhages, while his fifth includes the atrophic changes, that is, the terminal results. These last two belong especially to brain tumors and are not considered in this paper.

In the infirmary records there were 184 cases of intracranial involvement of otitic origin with fairly reliable data on the eye conditions. I probably searched as many more records of similar cases in which no mention was made of the eyegrounds. Some of these were emergency cases and it is also possible that in others in which the eye examination revealed no changes, the records did not so state, but in many the importance of following the fundi changes did not seem to be fully appreciated.

Records of the fundi were found in fifty-nine cases of brain abscess of otitic origin. Of these, forty were temporosphenoidal and nineteen were cerebellar.

TEMPOROSPHENOIDAL ABSCESSES

Sixteen of these cases showed normal fundi. Four patients had blurring of the disk margins; six, slight papilledema, and fourteen, marked papilledema. Thus, 60 per cent. had definite optic nerve changes. The edema was more marked on the affected side in seven cases, and on the unaffected in one. Seventy per cent. of these temporosphenoidal

2. Bordley, James, Jr.: The Significance of Papilledema to the Ophthalmologist, Tr. Am. Acad. Ophth. & Oto-Laryngol., 1924, p. 86.

cases terminated fatally. Of these patients, 65 per cent. had papilledema, while of those who recovered only 45 per cent. showed optic nerve changes.

CEREBELLAR ABSCESSES

Six of these patients had normal fundi; two, dilatation of the retinal veins; two, blurring of the disk margins; five, slight papilledema and four, marked papilledema. Thus, 58 per cent. showed optic nerve changes. This differs considerably from the findings of Friesner and Braun,[3] who state that "optic nerve changes were present in sixteen of the eighty-six cases" (that is, 18.6 per cent. as contrasted with 58 per cent. in my series). They also state "the condition found is usually an optic neuritis but occasionally there is a choked disk." In my cases, nine (or 50 per cent.) of all the eye changes were classed as papilledema and but two (or 8 per cent.) as optic neuritis. The edema was more marked on the affected side in three cases, and on the unaffected in one. Sixty-two per cent. of the cerebellar cases terminated fatally. Of these patients, 50 per cent. had papilledema, while all of those who recovered showed some optic nerve changes.

MENINGITIS

The fundi were examined in sixty-three cases recorded as meningitis from middle ear infection. Thirty-five of these patients had normal fundi; two, dilatation of the retinal veins; sixteen, blurring of the disk margins; three, slight papilledema and eleven, marked papilledema. Thus, 44 per cent. showed optic nerve changes. There were but two recoveries, both showing slight papilledema. In one of these cases the spinal fluid was turbid, under increased pressure and contained 800 cells but no bacteria. Possibly the diagnosis may be questioned. In the other case the spinal fluid was under increased pressure, turbid, contained 65,000 cells, and cultures showed large cocci in short chains, probably streptococci. A later spinal puncture gave a clear fluid, not under pressure, 200 cells and no growth.

Records of the spinal fluid were found in 65 per cent. of these meningitis cases. In 83 per cent., the fluid was under increased pressure, while in the remainder it was considered to be either normal or subnormal. The fundi were reported as negative in 53 per cent. of the cases with spinal fluid under increased pressure. In all the cases showing definite elevation of the disk, the pressure of the spinal fluid was increased, while in three of the cases showing slight blurring of the disk margins the pressure was considered to be normal. Bacteriologic

3. Friesner, I., and Braun, A.: Cerebellar Abscess, New York, Paul B. Hoeber, 1916, p. 107.

examination of the spinal fluid was recorded in 50 per cent. of the meningitis cases. Two of these showed staphylococci; fifteen, streptococci; six, pneumococci, and eight, no bacteria.

In the thirty-four cases with spinal fluid under pressure, examinations for bacteria were recorded in seventeen. Streptococci were found in six, pneumococci in four, staphylococci in two and no bacteria in six. In the fourteen cases with papilledema, streptococci were reported in three. In the sixteen cases with blurring of the disk margin the fluid was examined for bacteria in five; in four streptococci were found and in one there was no growth. Of the thirty-five normal fundi cases, spinal fluid was examined for bacteria in fourteen; four showed streptococci; two, staphylococci; six, pneumococci, and five had no growth.

The two cases with dilated retinal veins showed streptococci. It was interesting to note that streptococci were the only bacteria found in the papilledema cases and that in none of the seven cases in which other bacteria were found were there fundi changes.

The importance of early examination of the fundi in suspected meningitis is emphasized by Kopetzky [4] who states:

> At an early stage the increase in the amount of cerebrospinal fluid produces a strangulated effect on the blood vessels of the optic nerve, and causes an eye ground picture which is fairly constant and highly significant. It results in a swelling of the papilla, and blurring of the outer margins of the disk, which must not be confounded with nor is it the real choked disk seen later in the disease. This sign, taken in connection with what has gone before, is of great diagnostic value.

The fact that sixteen out of the thirty cases with fundi changes were of this early type bears out Kopetzky's statement.

The sixteen cases with negative fundi but increased spinal fluid pressure do not support Beck's statement made in discussing Jobson's [5] paper. He says:

> The cause of optic neuritis, or choked disk, I think has been proved to be a mechanical impediment. Dail of Prague at the Russian Medical Congress, showed the way the veins enter the optic nerve sheath. This fact led me to a study of the relation of the spinal fluid, or rather, the result we get from spinal puncture associated with choked disk. I have never seen a case of intracranial trouble in which the spinal puncture came with a marked spurt, that did not also show a choked disk. Conversely, in the absence of the choked disk the spurt of the spinal puncture has not occurred.

It is possible, however, that the "marked spurt" in Beck's statement may not be synonymous with the term "increased spinal fluid pressure," as used in the infirmary records.

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4. Kopetzky, S. J.: Contributions Toward the Early Diagnosis of Meningitis, Tr. Am. Acad. Ophth. & Oto-Laryngol., 1912, p. 263.

5. Jobson, J. B.: Ocular Symptoms of Brain Abscess and Sinus Thrombosis of Otitic Origin, Tr. Am. Acad. Ophth. & Oto-Laryngol., 1914, p. 27.

LATERAL SINUS INFECTION

Records of the fundi were found in sixty-two cases of infection in the lateral sinus. Twenty-nine of these had normal fundi; four, dilatation of the retinal veins; thirteen, blurring of the disk margins; eight, slight papilledema and eight, marked papilledema. Thus, 40 per cent. of the sinus infection cases showed some optic nerve changes, the most common being blurring of the disk margins.

Lumbar puncture was performed in eleven of these sixty-two cases. The spinal fluid was cloudy in four, clear in seven, under pressure in nine and normal pressure in two. Of the nine cases in which the spinal fluid was under pressure the fundi were normal in four, showed definite papillitis in three and slight blurring of the disk margins in two. In the two cases with normal pressure of the spinal fluid the fundi were normal.

In removing the spinal fluid from a patient with meningitis and marked papilledema, respirations became labored and the patient died, probably from herniation of the brain into the foramen magnum. This possibility should always be borne in mind, and to guard against it Dr. James B. Ayer, our neurologic consultant, suggested the following method of removing some of the cerebrospinal fluid, which I used successfully in a recent case with a papilledema of 5 diopters. This method, which is similar to that frequently employed before removing a cerebellar tumor, consists of a preliminary puncture of the lateral ventricle, preferably on the uninvolved side, through a small trephine opening in the parietal protuberance. When the lateral ventricle is reached, the pressure of the fluid is noted by attaching a manometer to the needle and enough fluid is withdrawn to bring it within normal limits. Then lumbar puncture can be performed with safety and the pressures in the spinal canal and lateral ventricle compared by manometers attached to the two needles. The pressure in these manometers should be equal unless there is some block in the cerebrospinal circulation.

In none of the 184 cases was the vision materially impaired, thus clearly distinguishing them from those optic nerve disturbances arising from infections in the accessory sinuses, teeth or tonsils.

Marked edema was most commonly found in the temporosphenoidal cases, in which 35 per cent. showed a swelling of over 2 diopters, as compared with 21 per cent. in the cerebellar cases, 17 per cent. in meningitis and 13 per cent. in sinus infection.

Slight edema of the disk, that is, a papilledema of under 2 diopters, was found in 15 per cent. of the temporosphenoidal cases, in 26 per cent. of the cerebellar cases, in 5 per cent. of the meningitis cases and in 13 per cent. of the sinus infection cases.

Blurring of the edges of the disk, or optic neuritis, was found in 10 per cent. of the temporosphenoidal cases, in 10 per cent. of the

cerebellar cases, in 25 per cent. of the meningitis cases, and in 21 per cent. of the sinus infection cases.

This is a most interesting point, as it shows that in the blood stream in the infectious type of cases, that is, in meningitis and lateral sinus infection, optic neuritis is the most common involvement.

Engorgement of the retinal veins was found in none of the temporosphenoidal cases, in 10 per cent. of the cerebellar cases, in 3 per cent. of the meningitis cases and in 6 per cent. of the sinus infection cases. This condition is not considered of any special significance but as it appeared on the records of the infirmary, it was necessary to record it.

The most marked papilledema noted in the cerebellar cases was from 5 to 7 diopters. Among the temporosphenoidal cases there were two with a swelling of 4 diopters and two of 3 diopters. There was one meningitis case with 7 diopters of swelling, and two with 3 diopters. None of the lateral sinus infection cases showed over 3 diopters.

Increasing edema usually indicates that the case is progressing unfavorably.

The tension of the eye was taken in a few cases, but Parker's [6] theory that the greater edema should be in the eye with the lesser tension could be neither substantiated nor disproved. We hope in future cases to obtain data on this point.

SUMMARY

When present in meningitis, brain abscess and lateral sinus infection, papilledema is a valuable diagnostic aid, but its absence does not exlude intracranial involvement.

Papilledema is classified under three headings:

1. Marked papilledema.
2. Slight or early papilledema.
3. Blurry disk margins or optic neuritis.

There was papilledema in 58 per cent. of the cerebellar abscesses, in 60 per cent. of the temporosphenoidal abscesses, in 44 per cent. of the meningitis cases and in 40 per cent. of the lateral sinus infections.

The fundi were normal in 50 per cent. of the meningitis cases with spinal fluid under pressure. Streptococci were the only bacteria present in the cases with papilledema.

As a preliminary to a lumbar puncture on a patient with marked papilledema, the intracranial pressure should be lowered by drainage of the lateral ventricle. Increasing edema of the optic nerve is usually an unfavorable symptom.

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6. Parker, W. R.: The Mechanism of Papilledema, Tr. Am. Acad. Ophth. & Oto-Laryngol., 1924, pp. 77-81.

ABSTRACT OF DISCUSSION

DR. GEORGE M. COATES, Philadelphia: Dr. White states an obvious truth when he says that valuable data are lost because no one operator sees a sufficient number of certain classes of cases to draw adequate conclusions, and it, therefore, becomes the duty of some one, from time to time, to go over hospital records and analyze larger series. Such an analysis of hospital case reports is, unfortunately, only too often marred by imperfect records of clinical and laboratory findings. This is, I think, becoming less common each year. The importance to the otologist and brain surgeon of competent and frequent eyeground examinations cannot be overestimated, as by this means the presence or absence of intracranial pressure may often be confirmed. The tabulation of percentages of different conditions in which papilledema was discovered is of great help in estimating the value of such positive and negative findings, and the importance of these findings, when positive, in determining the time for operative intervention. A statistical paper is of great value when it can be studied carefully in detail and at leisure, but it is more difficult to discuss off-hand in limited time. Certain facts, however, have been brought out by Dr. White that may profitably be emphasized. He says that 60 per cent. of the recorded cases of temporosphenoidal lobe abscesses showed definite optic nerve changes and that 70 per cent. of the total number terminated fatally. Of the fatal cases, 65 per cent. had papilledema which is practically the same as for all cases in the series, so that we cannot use this means in reaching a definite prognosis, although on the whole cases showing marked nerve changes have a poorer prognosis than those with none. Of course, it must be remembered that this series extends over a period of thirty years, during the first half of which the prognosis for all cases of abscess was less good than it is today. The presence and the amount of papilledema are some indications as to the presence and amount of intracranial pressure, but the location of the abscess and its slow or rapid growth are equally important factors in considering the interpretation of this symptom, and without this detailed information too rigid deductions cannot be drawn.

In cerebellar abscess the proportion of eyeground changes is almost the same as in cerebral abscess, which is contrary to what I have been accustomed to think is the usual ratio. The series is a small one, however, so that the findings might be reversed in a larger number of cases.

The whole question of meningitis needs careful study in the light of the information that Eagleton has shed on it in recent years. There are so many different classifications possible that we cannot say in a given case whether or not we should expect papilledema. A circumscribed pachymeningitis or leptomeningitis in a certain locality might be expected to produce this result, while a meningitis serosa, Eagleton's protective mechanism, if mild and exerting little pressure, would not produce this result. Obviously, without detailed case and necropsy reports, it is impossible to classify these cases, and speculation is not altogether satisfactory. Two of his sixty-five patients recovered, at least one of whom probably had a serious case, both recovered cases showed only slight nerve head change. It is significant that in all cases showing definite elevation of the disk, the spinal fluid was under increased pressure.

As would be expected, lateral sinus thrombosis gave the smallest percentage of nerve head change. Toby has shown that there is a definite rise in spinal fluid pressure when the sinus becomes occluded, but there are many cases of partial obstruction in which this probably does not take place until meningitis

supervenes. Possibly a considerable proportion of the 40 per cent. showing a pathologic condition of the eye had this added complication, which would really throw their cases into the meningitis group.

It is important to note that in not one of these cases of papilledema was the vision impaired to any appreciable extent. This seems remarkable to me, and I am not quite clear in my mind why this should be so when the contrary is the rule in cases of accessory sinus disease. I am interested in hearing the author's explanation.

Dr. C. F. Yerger, Chicago: In eighteen cases of otitic brain abscess observed at Cook County Hospital in which the diagnosis was confirmed either by operation or necropsy, papilledema was present in only three cases. In a few of the cases a fundus examination was not made, but it is our rule to examine all of these cases ophthalmoscopically. As a rule, we have been disappointed by the information we expected to get from this aid to diagnosis; nevertheless, as an auxiliary to the other important adjuncts, such as the examination of the cerebrospinal fluid, the other symptoms and signs of increased intracranial pressure, such as bradycardia, headache, vomiting, etc., and the focal signs, it occasionally adds its quota to the sum total from which we are able to make a correct diagnosis of brain abscess. Papilledema was of no value in localizing the brain abscess to one or the other hemisphere of the brain; nor was it an aid in differentiating a brain tumor from a brain abscess, as was demonstrated in one case in which the cerebrospinal fluid cell count showed 28 cells, mostly lymphocytes, and a positive globulin test. Choked disks were present. Necropsy showed an occipital lobe abscess. In a case of temporal lobe abscess found at operation, a bilateral papillitis was present; also bradycardia and a cell count of 350. In another case of temporal lobe abscess which came to necropsy choked disks were present; also bradycardia and 370 cells.

Regarding the optic nerve findings in Dr. White's cases in the group classified as a slight blurring of the disk margins and especially the nasal half of the disk, we should not confound the cases in which this is due to refractive errors, such as astigmatism, and also those due to optic neuritis due to focal infection. I should like to emphasize the necessity of repeated cerebrospinal fluid and fundus examinations during the period of observation for diagnosis and also postoperatively, in order to determine as accurately as possible the clinical course of the intracranial complications of otorhinogenic origin.

Dr. Leon E. White, Boston: Answering Dr. Coates in regard to the vision: The pathologic condition we have to contend with in cases of edema of the optic nerve from infection of the accessory sinuses is an entirely different problem from that due to infiltration of the cerebrospinal fluid about the optic nerve. The cases from accessory sinuses infection are of an inflammatory nature. There is swelling of the tissue of the sheath of the optic nerve or the nerve itself. If papilledema due to increased intracranial pressure continues a long time we will probably get impairment of vision as in tumors of the brain.

PROGRESS IN OTOLARYNGOLOGY

A Summary of the Bibliographic Material Available in the Field of Otolaryngology

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ACUTE AND CHRONIC SUPPURATIVE OTITIS MEDIA

INCLUDING ACUTE INFECTION OF THE BLOOD STREAM

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(Continued from page 281)

PRIMARY MASTOIDITIS

The discussion of primary mastoiditis may perhaps seem beyond the scope of this article; but since the middle ear condition accompanying it must be taken up, some note must be taken of the lesion itself. Heggie and Knauer,[20] Wagers[21] and Diehl,[22] among others, have reported cases of acute mastoiditis, all of the coalescent type, in which there was no evident involvement of the middle ear at any time. The otoscopic picture showed at most nothing more than a slight discoloration of the drum. No aural discharge was ever noted; there was no bulging of the drumhead, no obliteration of the landmarks and no foreshortening of the light reflex. The advent of the mastoiditis was marked by local and constitutional reactions in the form of swelling over the mastoid process, fever, increased leukocytosis and definite destruction of the cellular structure, as noted on the roentgen-ray plates. These cases are interesting. A more thorough investigation of them may perhaps reveal the cause of their occurrence and the mechanics of their development to be different from the usual evolution of infections of the mastoid process. In Diehl's case, a pneumococcus was found, which may account for the transitory involvement of the middle ear, if we are to accept Urbantschitsch's classification of mucosusotitis. In other instances the type of organism is not recorded. Whether this type of disease is dependent on some specific organism which causes the lesion, whether certain anatomic peculiarities exist in the mastoid process which permit of a

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20. Heggie, N. M., and Knauer, W. J.: Mastoiditis Without Apparent Involvement of the Middle Ear, J. A. M. A. **84**:1044 (March 29) 1924.

21. Wagers, A. J.: Acute Mastoiditis, Apparently Primary in an Infant Seven Months of Age, Laryngoscope **34**:453 (June) 1924.

22. Diehl, J. E.: Report of a Case of Mastoiditis, Epidural Abscess with Apparently no Middle Ear Involvement, Virginia M. Month. **51**:223 (July) 1924.

direct infection of the mastoid antrum without involving the middle ear, or whether a transient otitic inflammation is present at first which subsides and never goes on to frank suppuration—these are the questions which come to mind in such cases. Maybaum, in discussing the presentation of three cases of this type by Almour at the May, 1925, meeting of the New York Academy of Medicine, believes that there is always some change in the middle ear, denoted by some alteration in the drum picture. On the other hand, Kopetzky has seen conditions like these develop during the course of some nasal or throat infection when the patient was under observation and supervision. At no time did the drum show any change from the normal, although it was periodically examined during the evolution of the lesion. The danger in cases of this type lies in failure to recognize and estimate the mastoidal involvement; as a consequence the lesion in the mastoid advances toward the endocranium. In all of Almour's cases, the inner table was found eroded at some point. The roentgenogram is a most valuable aid in the diagnosis of this type of lesion.

INFECTIONS OF THE BLOOD STREAM

Smith,[23] in discussing the etiology and diagnosis of lateral sinus thrombosis, states that the diagnosis of this condition in early cases is almost impossible. Just what is meant by "early cases" is not clear. Infection of the lateral sinus is usually signalized by decidedly characteristic symptoms. If Smith contends that a blood stream infection is difficult to diagnose in the early stage, during the presence of the lesion in the mastoid process but before operation has been undertaken thereon, then there is some accord of views. Even at this stage, however, there are significant signs and symptoms in a certain proportion of cases.

When, before the performance of a mastoidectomy, there is edema present over the mastoid process, a swelling described by Greisinger which is not a subperiosteal abscess, it is taken to indicate a disturbance of the circulation in the vicinity of the venous supply of the temporal bone, and should be recognized as a sign of surgical diagnostic import. Experience has shown this sign to be associated with an involvement of the sinus in the great majority of instances in which it was observed. Sometimes a perisinal abscess was found, sometimes a thrombosis.

In this connection, grouping the mastoiditides into the acute coalescent and the acute hemorrhagic types helps in the recognition of the earlier stages of sinus thrombosis. After operation on a mastoid process, when surgery has revealed a coalescent type of lesion, the persistence of intense unilateral headache is significant. In connection with signs of

23. Smith, S. MacC.: Etiology and Diagnosis of Lateral Sinus Thrombosis, Atlantic M. J. **27**:255 (June) 1924.

sepsis during the postoperative period, it is almost pathognomonic. On the other hand, in cases of acute hemorrhagic mastoiditis (Kopetzky [24]), a progressive reduction in the hemoglobin and in the total number of the red blood cells is a valuable guide. These are pertinent factors which tend to make possible the diagnosis of septic sinus thrombosis in the early stages of its development, and without placing too great a reliance on the results of blood culture. Finally, as Smith points out, the presence of changes in the ocular fundi is of moment. Repeated examinations of the optic disk are frequently helpful when the suspicion of a sinus thrombosis is entertained. Changes varying from a mild papilledema to a marked optic neuritis on the side affected by the thrombosis may be remarked. Smith considers such findings almost pathognomonic of sinus thrombosis when they occur in the presence of a tympanic suppuration, associated with rigors and other signs of sepsis.

His contention, that pyemia is rare in aural suppuration which is not associated with sinus thrombosis, does not accord with the latest views on the subject. In the type of hemorrhagic mastoiditis that has been termed osteothrombotic phlebitis by Körner, and which has been reestablished in our literature in a slightly varied form (by Beck in his thrombotic type of mastoiditis, by Kopetzky in his hemorrhagic type), pyemia is observed with no gross involvement of the lateral sinus. The systemic infection in such cases originates from the small infected thrombi within the vessels of the bony intercellular walls of the mastoid process, and in the membrane which lines the mastoid cells. In this connection it is interesting to note that in forty-eight patients on whom Boyd-Snee [13] operated, and in whom the streptococcus organism was demonstrable, thrombi of the venules of the mastoid process were observed in the surgical findings. In such cases, the lateral sinus rarely reveals a thrombus when opened. Usually a cure and full recovery are effected by means of the simple mastoid operation.

Fraser's statistics,[25] showing the greatest percentage of sinus thrombosis to follow chronic infections of the middle ear and mastoid (75 per cent. after chronic purulent otitis media), are in accord with those of the majority of the European observers. One element of danger in the chronic cases lies in the amount of eburnation which the diseased mastoid process has undergone prior to the onset of the acute attack, which ushers in the lesion in the blood vessel. This accounts for one variety of sinus infection found in chronic cases. In the type of mastoiditis which comes to operation because of a cholesteatoma or of marked bone caries, a thrombus is occasionally demonstrable in the sinus, when it is

24. Kopetzky, S. J.: Systemic Infections Complicating Middle Ear Disease, J. A. M. A. **83**:336 (Aug. 2) 1924.

25. Fraser, J. S.: Septic Otitic Thrombosis of the Cranial Blood Sinuses and Jugular Bulb, J. Laryngol. & Otol. **39**:253 (May) 1924.

an incidental discovery. Such thrombi never produce significant symptoms. They have their origin in the narrowing of the lumen of the blood vessels and the consequent slowing of the blood stream, caused by pressure exerted on the vessel extraneously by the cholesteatoma, and they are sterile on culture. They are to be regarded as aseptic and asymptomatic. Of course, such lesions of the blood vessel may become secondarily infected. Then the usual clinical picture supervenes. Fraser's note, that blood culture is of value only when positive, has been substantiated by the experience of most competent observers.

In this country, statistics on the frequency of blood stream infections do not quite so definitely establish the occurrence of the larger number in the chronic mastoiditides. In the more recent literature, a large percentage of blood stream infections has been reported in acute cases, especially by those men whose experience with the influenzal type of mastoiditis is wide.

Giesswein [26] disputes the claim of Brieger that pulmonary metastases are more common following sinus thrombosis, which is a sequela of chronic infection, than following sinus thrombosis which accompanies, or is subsequent to, an acute infection. (Brieger also claims that there is a different metastatic distribution following the two types of acute mastoid disease.) Giesswein concludes that there is no difference between the metastasis in acute and chronic middle ear diseases. His view seems to be the more correct. It is somewhat in line with the belief of Rosenau that bacteria exert a selective action for certain types of tissue. For instance, pneumococcus and *Streptococcus mucosus-capsulatus* invariably affect the endocranium after invading the mastoid. *Streptococcus hemolyticus* shows several strains, one selecting the joints and serous membranes, another the superficial structures such as the skin and muscles, while still another attacks the lungs. It does not seem that the distribution of metastatic lesions depends on the character of the lesion in the mastoid, but rather on the type of organism presented and its inherent selectivity. The suggestion of Giesswein, that the presence of anaerobic organisms in the chronic infections causes a finer division of the thrombi and that these smaller particles are arrested in the pulmonary capillaries, is too theoretic a deduction. Metastases are not dependent on disorganization of the thrombus and the spread of its particles into the general circulation. The living bacteria themselves escape into the blood stream. These are much finer than any portions of broken down thrombi and can be carried everywhere that the blood reaches.

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26. Giesswein, M.: Clinical Aspects of Sinus Thrombosis, Beitr. z. Anat. Physiol., Path. u. Therap. d. Ohres **20**:195 (Jan.) 1924.

TREATMENT

In the management of septic sinus thrombosis, the usual procedure of eradicating the lesion in the lateral sinus and then either ligating or resecting the internal jugular vein is still our chief recourse. Chatéllier [27] modifies this view somewhat. He holds that while sinus thrombosis with manifest pyemia necessitates both the removal of the thrombus and the ligation of the internal jugular vein, a thrombosis which is strictly localized, gives no septicemia and yields a sterile blood culture, requires operation on the lateral sinus alone. This suggestion should be considered seriously, as there are many points to be said for as well as against it. First, however, disagreement may be taken with Chatéllier because he places too much emphasis on the results of blood culture. A metastasis may exist with no positive findings in the blood, for, as is well known, it may act as a "fixation abscess" which clears the blood stream. At any rate, it is recognized that artificially produced fixation abscesses in many instances have served to render blood sterile when it was positive before. One should realize that it is entirely possible to have a local focus of suppuration in the blood channels which is limited to one portion of the vein. That this focus may eventually break through the barriers set up around it, is taken for granted; but it is also conceivable that with the removal of the local infection in the larger sections of the blood vessel, the danger of further systemic invasion may be stopped. At the hands of an experienced operator, on the other hand, the isolation and resection of the internal jugular vein puts no added burden on the patient, and in no way tends to alter an otherwise favorable course. It may, in fact, increase the margin of safety by localizing the lesion. What is to be gained by following Chatéllier's suggestion must, therefore, still be weighed before his conception can be accepted generally.

ANATOMIC NOTES

In most of the textbooks and in the current literature, the membrane lining the middle ear and the mastoid cells is usually considered a mucous membrane. Krainz's [28] study of this membrane demonstrates that it lacks a tunica propria. In other mucous membranes of the body, the tunica propria serves to carry the glands, nerves and lymph nodes and is, therefore, the real secreting mechanism. On this basis Krainz does not believe that the lining membrane of the mastoid cells should be regarded as a true mucosa, since its substratum is a specifically differentiated tissue with a tendency toward osteoblastic activity. This

27. Chatéllier, H. P.: Considerations sur les thrombophlébites sinuso-jugulaires des oto-mastoiditis, Ann. d. Mal. de l'oreille, du larynx **43**:1-43, 1924.

28. Krainz, W.: The Lining of the Pneumatic Cells of the Mastoid, Ztschr. f. Hals-, Nasen- u. Ohrenh. **6**:415, 1923.

finding is important, and may explain the tendency on the part of the mastoid structure to form dense eburnated bone when confronted with a suppuration of long standing. Krainz [29] proposes the term "endosteum pneumaticum" for the membrane lining the mastoid.

TISSUE REPAIR

Caldera [30] has studied the processes of repair in the realm of otology. He states that the repair of a perforation of the drum is uniformly atypical following acute otitis media, and that the drum structure over the healed perforation differs from the remainder of the intact drum, no matter how small the perforation may have been. The cicatrix which forms over the deficiency consists only of the two layers of epithelium, cutaneous and mucous, and the supportive connective tissue does not regenerate. It sometimes happens that the new bridge of epithelium becomes impregnated with lime salts to the extent of ossification.

Caldera's statement—that bone formation is possible from the granulations in the operated mastoid wound—does not accord with the generally held views. In many patients seen at reoperation, the mastoid cavity was filled with nothing but dense fibrous tissue which exhibited none of the characteristics of bone. The cortex, however, was found to have regenerated in many instances in which the periosteum had been kept intact at the first operation.

TREATMENT NOTES

In reporting on the efficacy of any method of treatment, the cases in question should be carefully typed. In most current reports of this kind, a deplorable lack of definite diagnosis exists, so that it is almost impossible to know just what kind of case and what particular lesion have been subjected to the therapeutic agent advocated. Thus Gailbraith [31] advises the use of ether instillations in cases of chronic suppurative otitis media. His report lacks exact diagnoses, since chronic suppurative otitis media is too general a term. One cannot draw conclusions as to the efficacy of a mode of treatment unless the lesion underlying the chronic suppuration has been established and is thoroughly understood.

In the treatment of acute middle ear infections, much has been written lately on that phase of therapy which is directed toward preventing the spread of an infection from the middle ear to the mastoid

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29. Krainz, W.: The Lining of the Air-Containing Mastoid Cells, Ztschr. f. Hals-, Nasen- u. Ohrenh. **8**:46, 1924.

30. Caldera, C.: Regeneration of Tissues in the Realm of Otorhinolaryngology, Arch. ital. di otol. **35**:200, 1924.

31. Gailbraith, E. G.: A Treatment of Chronic Suppurative Otitis Media, Ohio State M. J. **19**:860 (Dec. 1) 1923.

process. Before discussing the value of this, let it be known that the main point in all forms of such treatment is the use of "suction" applied to the middle ear. In addition to other measures, Wolfe [32] and Schwartz [33] advise the application of negative pressure to the middle ear once or more during the day. Schwartz modifies the usual paracentesis incision in the posterior portion of the drum by extending it further upward and inward along the superior wall. When mastoid tenderness is present, another incision is made joining the first so as to produce a Y-shaped gap in the drum. Wolfe likewise advocates general building up of the body resources, with specific treatment directed against the various constitutional and nutritional diseases, besides the local employment of suction in the tympanum.

It is to be deplored that in the advocacy of "suction" as a preventative of mastoiditis, little or no consideration is given to the pathogenesis of mastoiditis or to the anatomic peculiarities in the middle ear which would seem to contraindicate aspiration. In the usual acute mastoiditis, that is, in that variety which has been termed the coalescent type, in which the disease in the mastoid process is the result of progression of the suppuration by contiguity of tissue, the mastoid process is the seat of a collateral edema at the time of the middle ear infection. This is evidenced not only by the presence of tenderness over the mastoid process in every case of acute middle ear purulency, but also by the roentgenologic findings, which show a definite clouding of the area but no destruction of the bony cellular structure. To state that such evidence constitutes a mastoiditis which would eventually require surgical intervention if suction is not employed, and to make the presence of tenderness over the mastoid area an indication for an extensive incision in the drum, are not in accord with the best opinion in otology. Infection of the mastoid process takes place by the spread of suppuration into the antrum mastoideum by virtue of the continuity of the membranous lining. Once the infection has reached the antrum, the bacteria play a minor rôle in the further development of the disease. Additional destruction in the mastoid process is now favored by the presence of stagnant pus under pressure, which causes a necrosis of the bony intercellular walls. The pressure cuts off the blood supply to the bony septums and they die.

An incision in the drum permits of drainage of the pus from the tympanic cavity. When the body resistance is capable of setting up a reaction in the contiguous membranous structure around the mastoid

32. Wolfe, O.: Routine Treatment of Acute Otorrheas with Especial Reference to Children, J. Iowa State M. Sc. **14**:4 (Jan. 10) 1924.

33. Schwartz, A. I.: An Effective Method for the Treatment of Acute Middle Ear Infections and the Prevention of Mastoiditis, M. J. & Rec. **119**:250 (March 5) 1924.

antrum sufficient to ward off further infection, no surgical mastoiditis develops. When, on the other hand, no such reaction takes place, the infection will spread, and no local treatment will halt further destruction. The use of suction, if anything, favors the advance of the disease asymptomatically. The numerous reduplicated folds of mucous membrane in the attic become markedly engorged following the use of suction, not only from an edema produced by the negative pressure, but by an actual increase in the size of the capillaries. This swelling of the epitympanic mucosa blocks off the mastoid antrum from the middle ear, and actually prevents the drainage of this area through the tympanum into the external auditory canal. Stagnation of pus in this region is thus enhanced.

Furthermore, the use of suction so alters the otoscopic picture that one is unable to judge the progress of the disease. The parts become markedly engorged and edematous, the drum swollen and boggy; the mucosa of the tympanum must then not only combat the infection already present, but repair the damages caused by the application of negative pressure as well.

Another element to be considered is the effect of suction on hearing. Even were suction capable of preventing surgical mastoiditis, the fact remains that the use of negative pressure is damaging to the ossicular chain. In all the patients studied, in whom suction had been employed, not only did the patient eventually come to operation on the mastoid process, but a diminution in hearing ensued, greater than that which ordinarily follows the subsidence of an acute middle ear infection. The use of suction is, therefore, to be deprecated, not alone as a routine, but even as an occasional measure, in the treatment of acute middle ear infections. It has no advantage over the more conservative forms of therapy in combating the infection per se, and it has not warranted its employment as a preventative of surgical mastoiditis. When the latter is present or is in the process of development, the utilization of negative pressure favors the advance of the disease and at the same time destroys the clinical syndrome by which the progress of the destruction in the given case may be judged.

Reports on the use of the zinc ionization treatment in acute and chronic ear discharge have been numerous. Among the most prominent papers are those of Jobson,[34] Kanter [35] and Schmidt.[36] Jobson reports 60 per cent. of all cases of otorrhea cured by this method. Kanter

34. Jobson, T. B.: Suppurative Otitis Media Treated by Zinc Ionization, Brit. M. J. **1**:371 (March 1) 1924.

35. Kanter, J. B.: Zinc Ionization in Ear, Nose and Throat Diseases, New York M. J. **118**:780 (Dec. 19) 1923.

36. Schmidt, V.: Zinc Ion Treatment of Acute and Chronic Middle Ear Suppuration, Acta Otolaryngol. **6**:568, 1924.

reports cures of chronic purulent otitis media in 75 per cent. of his cases. Schmidt obtained more rapid disappearance of the aural suppuration in all acute cases (the average being ten days); in fifty-one cases of chronic suppuration twenty-one secured a dry perforation and twenty were improved. He states that among the latter type were patients who ordinarily would be subjected to a radical mastoid operation.

These reports, while encouraging, are nevertheless inaccurate guides, in that no attempt is made to classify the cases treated from a pathologic standpoint. Chronic purulent otitis media is in itself a generic term, and includes all those diseases capable of producing a chronic discharge from the middle ear. Thus bone necrosis, malignant disease of the ear, chronic suppuration of the tympanic mucosa, cholesteatoma and foreign bodies in the ear, all have the one symptom in common, that is, a discharge of long standing from the middle ear. In that type of chronic otitis in which the disease is limited to the mucous membrane of the tympanum, the discharge is almost always of the intermittent type, and finds its etiology in suppurative conditions in the nasopharynx. The great majority of such conditions will be entirely cured once attention has been given to the nose and throat. No one ever advocates surgery on the temporal bone for the relief of this condition per se. On the other hand, while cases of cholesteatoma, malignant growths and simple bone necrosis also present a chronic purulent otitis media, the cause of their otorrhea lies in a progressive destruction of the bone in the tympanomastoid area. No one would expect to cure malignancy by the method of treatment now under discussion. Jobson failed to obtain any beneficial results in his six cases of cholesteatoma; and it is doubtful in the extreme that this lesion would ever be relieved by such treatment. Consequently, among those cases of otitis media purulenta which present indications for radical surgery on the mastoid process, there is but one condition that may reasonably be expected to respond to the zinc ionization treatment, namely, chronic otorrhea due to simple caries.

None of these reports attempt to tabulate results according to the pathology presented, so that the observations and statistics contained therein are of limited value. A study of the zinc ionization method, as well as any other advocated for the cure of chronic purulent otitis media, should contain an accurate and detailed classification of the effects of the treatment, according to the various types of the disease presented. In this manner, useful information would be obtained for the intelligent application of a prescribed method. If the zinc ionization treatment is successful in even a small percentage of cases, it will be a welcome addition to our therapeutic armamentarium.

The foregoing also holds true for the work of di Donata,[37] who studied the effects of injections of foreign proteins and autogenous vaccines on the course of chronic purulent otitis media. Valentine's studies [8] give us the reason for the failure of the autogenous vaccines to act as specifics.

On the other hand, Madritsch [38] reports favorable results in the treatment of all forms of otitis media by injections of aseptic milk. His results were obtained without any febrile reaction, and without any change in the differential leukocyte count. He considers the action of the milk to be due to the changes in the colloidochemical condition of the body, and states that the fever reaction is in no way necessary, or responsible, for the curative change.

Friedel [39] reports a case of "mastoiditis and otitis media" cured by the use of diathermia and reflected incandescent light. The diagnosis of mastoiditis was based on the fact that the roentgen ray showed the mastoid cells and antrum to be "involved," and that tenderness over the mastoid process was very acute. After the use of diathermy and reflected incandescent light, the discharge from the middle ear stopped in a few days. The reports of such apparently phenomenal cures for what ordinarily requires surgical intervention are misleading, and are apt to result in more harm than good. Even if the case reported by Friedel was a real case of surgical mastoiditis, it is but an isolated instance and should not form a basis for even the occasional employment of the method advocated. Reports of treatment based on a small number of cases must be carefully estimated. Too much stress should never be laid on them. Too often laymen, and even some physicians, on hearing of such isolated cases, will take them as reason for delay when surgical intervention is necessary. In this particular instance, the diagnosis of a surgical mastoiditis from "involvement" of the mastoid cells and extreme tenderness must be questioned. As has already been stated, all cases of acute purulent otitis show an "involvement" of the mastoid cells in the form of "clouding." Friedel does not state the amount of cellular destruction, if that is what he means. All otologists have seen cases of real mastoiditis, with definite cellular destruction revealed on the roentgenogram, which, under palliative measures, resolved without resort to operation. Always, however, the roentgen ray shows a definite clouding of the area involved for a long

37. di Donata, D.: Variations in the Opsonic Index for the More Common Microorganisms of Chronic Purulent Otitis Media and Its Complications in Patients Treated with Autogenous Vaccines and Foreign Proteins, Arch. f. Ohrenh. **111**:269 (June) 1924.

38. Madritsch: The Effect of Parenteral Administration of Aseptic Milk in Otitis Media, Monatschr. f. Ohrenh. **58**:614 (July) 1924.

39. Friedel, H.: Mastoiditis and Otitis Media Treated by Diathermy and Reflected Incandescent Light, Am. J. Electrotherap. **42**:64 (Feb.) 1924.

time after the subsidence of the suppuration. This clouding is due to the presence of the connective tissue which replaces the destroyed cellular structure. In Friedel's case, he states that roentgenograms, taken subsequent to the cessation of the aural discharge, showed more shadows on the healthy side than on the one formely diseased. Cellular regeneration certainly does not take place in an adult, aged 40 years. Regardless of the questionable diagnosis, however, papers like this tend to confuse the otologist and are very often misleading to our younger confrères.

51 West Seventy-third Street.

News and Comment

AMERICAN BOARD OF OTOLARYNGOLOGY

An examination was held by the American Board of Otolaryngology on May 26, 1925, at the Medico-Chirurgical Hospital, Philadelphia, with the following result: passed, 137; failed, 20; total examined, 157.

The next examination will be held at the University of Illinois School of Medicine on Oct. 19, 1925. Applications may be secured from the secretary, Dr. H. W. Loeb, 1402 South Grand Boulevard, St. Louis.

LOCAL SOCIETY MEETINGS

PHILADELPHIA: Section on Otology and Laryngology of the College of Physicians of Philadelphia meets on the third Wednesday of each month from October to June, at 8:30 p. m., at the College of Physicians. Chairman, Dr. Fielding O. Lewis; Secretary, Dr. James A. Babbitt, 2117 Chestnut Street.

CLEVELAND: Ophthalmological and Otolaryngological Section of Cleveland Academy of Medicine meets on the fourth Friday of each month at the Winton Hotel. Chairman, Dr. E. W. Garrett; Secretary, Dr. M. Paul Motto, Rose Building.

CHICAGO: Chicago Laryngological and Otological Society meets on the first Monday of the month from October to May at the Crystal Room, Great Northern Hotel. Chairman, Dr. E. H. Norcross; Secretary, Dr. A. A. Hayden, 25 East Washington Street.

MILWAUKEE: Milwaukee Oto-Ophthalmic Society meets on the third Tuesday of the month, at the University Club, at 6:30 p. m. President, Dr. John E. Guy; Sec.-Treas., Dr. John J. Brooks, Majestic Building.

KANSAS CITY, MO.: Kansas City Eye, Ear and Nose Society meets on the evening of the third Thursday of each month from September to May, at the Baltimore Hotel. The afternoons of the third Thursday of November, January and March are given over to clinical work. President, Dr. James May; Secretary, Dr. A. E. Eubank.

Abstracts from Current Literature

Ear

Functional Disturbances of the Otoliths in Ear Disease. G. Tenaglia, Arch. ital. d. otol., rinol. e laringol. **36**:257-271, 1925.

From his researches Tenaglia reached these conclusions: Functional disturbances of the otoliths are more in evidence in acute ear disease, and particularly in chronic conditions that have become, for the time being, acute, whether of an inflammatory, a traumatic or a toxic nature. They occur more frequently in the otoliths of the saccule than in those of the utricle. The former are associated more commonly with disturbances of hearing, while the latter are accompanied practically always by signs indicative of irritation of the semicircular canals.

Wolcott, Chicago.

Concerning the Hearing Region of Bezold b^1-g^2 and the Location of Speech Sounds in the Tone Scale. S. Kompanejetz, Ztschr. f. Hals-, Nasen- u. Ohrenh. **11**:209 (July 20) 1925.

According to Kompanejetz, Bezold's principle does not always hold good, concerning the co-relation between the hearing region b^1-g^2 and the ability to perceive single vowels and consonants on the one hand, and the location of the vowels and consonants in the tone scale on the other. There are exceptions to this rule which should give rise to a revision of the whole question.

Contribution to the Pathologic Anatomy and Pathogenesis of Deafmutism. III. Bilateral Complete Destruction of the Membranous and Osseous Labyrinth, With Spontaneous Healing, as a Cause of Deafmutism. O. Steurer, Ztschr. f. Hals-, Nasen-u. Ohrenh. **11**:339 (July 20) 1925.

The changes found in temporal bones of deafmutes do not differ generally in kind from residues of inflammations in nondeafmutes. Yet there are some peculiarities concerning the genesis, because labyrinth changes in deafmutes are bilateral. In later life unilateral inflammations of the labyrinth are caused by an acute or a chronic middle ear suppuration, especially a choleastomatous suppuration; the inflammations of the labyrinth which develop in early youth bilaterally are more frequently the results of a specific or nonspecific meningitis. A smaller number of the inflammations of the labyrinth in early youth can also develop after necrotizing middle ear inflammations in scarlet fever and measles. The more pronounced changes may be localized in the membranes of the windows and in the semicircular canals in tympanogenic labyrinthitis, and in the aquæductus cochlearis and the cochlear nerve in meningogenic labyrinthitis. The pathologic anatomic changes caused by inflammatory processes in the labyrinth are especially known by the comprehensive studies of Friedrich, Goerke, Hinsberg, Manasse, Uffenorde and Zange. As the final stage of the lightest form of labyrinth inflammation, of serous labyrinthitis (labyrinth hydrops), degenerative changes of the epithelial covering of the endolymphatic spaces can be seen, especially atrophy of the stria vascularis and of Corti's organ. The latter may disappear entirely. These changes may frequently be connected with

an enclosing growth of epithelium, with changes of the form and position of Corti's membrane and dilatation of Reissner's membrane (posthydropic degeneration of the neuro-epithelium [Wittmaack]). Such changes have been described previously by Steurer. In the sero-fibrinous and in the lighter form of suppurative inflammation of the labyrinth the exudate is changed into connective and finally into osseous tissue. In the final stages of this form of inflammation the perilymphatic spaces are filled, partly or completely, with more or less compact masses of connective tissue or bone (connective tissue or osseous obliteration of the labyrinth [Wittmaack]). In these cases the endolymphatic spaces show mostly degenerative changes as described before as posthydropic degeneration of the neuro-epithelium. Findings of this nature in temporal bones of deafmutes have been described in great numbers, among others by von Stein, Denker, Alexander and Neumann, Linck, Uffenorde. The grave forms of suppurative labyrinthitis and the necrotizing inflammations of the labyrinth which lead to a suppuration respectively necrotizing destruction of the soft parts of the labyrinth and frequently to lesion and destruction of the adjoining osseous capsule of the labyrinth, heal in the following manner. The whole inner ear is changed into a uniform firm mass of connective or osseous tissue. In contradistinction to the osseous obliteration of the labyrinth after fibrinous inflammation, the former cannot be discriminated against the surrounding old osseous structure of the labyrinthian capsule (according to Wittmaack, labyrinth destruction ending in phthisis of the labyrinth). Steurer describes such a case in full. The patient, a woman, aged 48, a deafmute, died of insufficiency of the heart. No particulars concerning the development of the deafmutism and previous diseases could be obtained. Steurer examined the temporal bone microscopically and could establish the fact that deafmutism resulted from bilateral destruction of the whole labyrinth with spontaneous cure by new formation of connective tissue and bone. With the exception of a similar but not quite so pronounced case described by Schwartze, Steurer does not know of a case of deafmutism, in the literature, with such pronounced changes of the inner ear. A peculiar change is mentioned by Steurer in the right temporal bone of the patient. In the right vestibule numerous nerve fiber bundles could be recognized crossing one another irregularly. They are newly formed fibers. Schwartze, Schwabach, Lange, Mayer, Zange, Brock and Preuss have described similar findings. Marx observed a new formation of nerve fibers in a pigeon after experimental destruction of the labyrinth. Whereas all the authors could show that the proliferating nerve fibers emanated from rests of the vestibular nerve, the arrangement of the newly formed nerve bundles in Steurer's case, points to the fact that they originated partly also from the descending branch of the facial nerve.

TESTING THE FUNCTION OF THE VESTIBULAR APPARATUS BY WEAK TURNING IRRITATION. KARL GRAHE, Ztschr. f. Hals-, Nasen-u. Orenh. **11**:391 (July 20) 1925.

If a person is turned slowly with open eyes no nystagmus is observed. When strongly convex spectacles are used (Bartels), nystagmus is noticed. The excursions of the eyeball can be felt through the closed eyelids. Cemach and Kestenbaum have claimed that this nystagmus is not dependent on the vestibular apparatus, but that optical influences were the cause. They had observed that deafmutes with unexcitable vestibular apparatus exhibited nystagmus behind Bartels spectacles with short turns. On the other hand, they did not notice any nystagmus in people with normal ears when they turned the same in a dark

room with a weak red illumination so that the examiner could not be fixed. Bartels reached other results. He observed in normal people also vestibular irritations with short turning time, but noticed that optic influences can influence the nystagmus. Blind people also exhibit plainly twitchings of the eyes under these circumstances. Bartels also observed twitching on turning after bulbus enucleation. Grahe confirmed this phenomenon. Cemach and Kestenbaum found that in deafmutes with unexcitable labyrinths, nystagmus can be palpated through the closed eyelids in the dark after a short turning time.

In the year 1892, Kreidl palpated the turning nystagmus in a large series of examinations. He examined the turning nystagmus in deafmutes by letting himself be turned on a board with the deafmutes and by palpating through the closed eyelids. In 109 patients nystagmus was missing in 50 per cent. He assumed labyrinthian changes according to Mygind, who found pathologic changes in the semicircular canals in 56 per cent. Strehl, Bezold, Denker, Hasslauer, Wanner, and Frey and Hammerschlag, verified these findings.

Aside from the fact that these authors used strong turning irritation the difference of the arrangement of the experiments compared with those of Cemach and Kestenbaum was that with those authors no changes in the position of the head in relation to the body took place during turning, whereas such neck reflex effects were not excluded by Cemach and Kestenbaum. The influence of the same on the eyes are not only known from the animal experiments of Magnus and de Kleyn. They also have been found in man. Bárány and others have found them in nurslings, and Grahe could show the influence on the duration of turning nystagmus in normal adults.

Grahe found that persons with excitable labyrinths did not show any nystagmus with short slow turning if the influence of neck reflexes was excluded. In order to support the connection of this nystagmus with the vestibular apparatus, Grahe made control experiments with sixty patients.

Method: The patient is placed comfortably with spread legs before the examiner and told that his head would be turned slowly to and fro. The patient is told not to turn the head himself, but must allow his head to be turned. The patient should allow the shoulders to move simultaneously. The patient's head is then bent a little forward. The head is then taken between the hands of the examiner. The second, third, fourth and fifth fingers take a firm hold of the temporal regions, whereas the balls of the thumb rest in the canine fossas. The thumbs are placed very gently on each side in the inner canthus on the closed eyelids. The elbows are placed against the shoulders of the patient and force them to participate in the turning. Then the patient is turned to the side so far as it can be done without changing the position of the hands. After stopping for a moment, the head of the patient is turned to the other side. The movement must be very even and not quick. The examiner himself must move to and fro so that the pressure on the eyelids remains the same. It is better to stand children on a chair. During the turning the single twitchings of nystagmus are plainly felt. Intensity and frequency are observed. After a short intermission one must turn back to the starting point with the hands kept in place. Again the intensity and frequency of the excursions of the nystagmus are observed. After a short intermission the examination is repeated a few times, without releasing the patient's head if possible. Great attention must be paid so that the head is turned to both sides evenly, because small differences are accompanied immediately by a change of the nystagmus. (By placing the middle and index fingers on the closed eyelids, and by turning gently to and fro one can try this out oneself.) It is important to turn slowly in order to count

the nystagmus. It is necessary to wait a little while after each turn because otherwise the nystagmus becomes irregular and the frequency decreases after some turns.

The influence of light was excluded by examining the patient in a semidark room, or opposite an evenly illuminated wall. One learns after a short time to differentiate simple lid movements from nystagmus excursions of the bulb. The first are directed from above downward and exhibit a fine whirring of the muscle. If one turns in this manner around an angle of about 90 degrees in about three seconds, the same number of nystagmus excursions are felt by turning to the right or to the left in a patient with a normal labyrinth. From five to seven beats are the average. Smaller numbers also occur not only in different people, but also in the same person at different times. For comparison Grahe referred to the turning chair nystagmus after turning ten times on the electric turning chair of the clinic, also to the examination for spontaneous symptoms and the caloric weak irritation (Kobrak). Grahe found that the nystagmus which could be felt through the closed eyelids with a short and slow turning was parallel in fifty-four out of fifty-six cases with excitability of the vestibular apparatus. Hereby a positive proof was furnished that also with short and slow turning the vestibular apparatus enters into action. Grahe summarizes that the palpation of the nystagmus through the closed eyelids, in short and slow turning, presents a very simple clinical method of examination of the vestibular apparatus. It has the advantage that no special apparatus is necessary as in turning with the turning chair. It corresponds with the physiologic conditions and is not disagreeable to the patients. Similar to the strong turning irritation method, it is only reliable as an examination for comparison when turning to the right and to the left, and its results clinically can only be utilized as part phenomena of the total subjective and objective vestibulary symptoms.

AMBERG, Detroit.

Larynx

EXPERIMENTAL EXAMINATIONS CONCERNING THE LOCALIZATION OF THE SINGLE MUSCLES OF THE LARYNX. VICTOR FRUEHWALD, Ztschr. f. Hals-, Nasen- u. Ohrenh. **11**:277 (July 20) 1925.

Fruehwald's experiments induce him to agree with those authors who assume the bilateral innervation of the muscles of the larynx. His results point in all probability to the fact that in apparently defined areas of innervation in the region of the nucleus of the vagus, the whole region is concerned. Those authors appear to be right who consider the region of the nucleus of the vagus to be an entity, although Fruehwald is of the opinion that this view should be considered only with limitations. A sharper limitation of the various regions of the nucleus should be aimed at.

AMBERG, DETROIT.

Nose

THE PATHOGENESIS OF OZENA. G. GRADENIGO, Arch. ital. d. otol., rinol. e laringol. **36**:33-37, 1925.

Gradenigo recalls that there are two predominant theories held in regard to the genesis of ozena: the pure infection theory, which admits solely the action of a definite infective micro-organism, and the constitutional-infection theory, which assumes, in addition to a specific infective agent, a constitutional predisposition to the disease. Gradenigo advances and defends a third conception, which might be called the purely constitutional theory, since he holds

hereditary predisposition to be the sole essential for the development of ozena and considers the bacterial flora of the nose as a merely accessory factor due to the pecular conditions of environment, notwithstanding the fact that the nasal flora exercises the prevailing influence in determining the clinical picture of the disease. All too often we confuse the causative agent of a single symptom of a disease with the determining cause of the disease itself. The constitutional predisposition to the disease is transmitted according to the principle of a mendelian recessive type and, as is true of other hereditary diseases, is aggravated by syphilis and tuberculosis in the ancestors of the subject. The theory of hereditary predisposition, without the intervention of a specific infective micro-organism, is in the closest accord with the results of clinical and bacteriologic research.

HEMATOLOGIC RESEARCHES ON ADENOIDS. DONATO DI DONATO, Arch. ital. d. otol., rinol. e laringol. **36**:164-174, 1925.

As the result of his researches on the hematology of adenoids, di Donato reached these conclusions: In the presence of adenoids, the lymphoid tissues are constantly in a state of hyperplasia, as is shown by the evident mononucleosis and the frequent occurrence of undeveloped or only partially developed lymphocytes (lymphoblasts or prolymphocytes). Such irritation induces in high-grade adenoids also hyperplasia of the myeloid tissues in the erythrocytes and the leukocytes, as is revealed not only by the presence of normoblasts, which have been demonstrated by many authors, but also by the increase of granular red blood cells and by Arneth's formula, which showed a shifting to the left, or a predominance of younger forms. There is a marked azurophilia in adenoids, and, if we assume, as do most authors, that this is an expression of a toxic state, it is logical to conclude that such patients are suffering from a chronic toxic infection (syphilis, tuberculosis), as will be brought out in a later article. In patients in a highly weakened condition, these phenomena are lacking, which points thus to a state of hematopoietic energy, in which the myelolymphoid tissues remain inert toward the irritative cause and leave the organism undefended.

THE TREATMENT OF OZENA. T. MANCINI, Arch. ital. d. otol., rinol. e laringol. **36**:238-239, 1925.

The good results secured in the treatment of affections of the throat and the ear by the application of silver iodid in the so-called nascent state induced Mancini to use it in ozena. For the last three years he has used this medication in the Gradenigo Hospital, Turin, giving two injections a week to about forty patients. The results have been satisfactory; in some cases a clinical cure was effected. But, while the fetor and the crusts were eliminated, the atrophy of the turbinates remained unaltered. To combat the latter condition, since December, 1923, he has used injections of warm white petrolatum with good results. It is too early to state whether the increased growth of the turbinates will remain constant. The author describes his technic with some detail.

WOLCOTT, Chicago.

EPISTAXIS AND ITS TREATMENT. AUREL RÉTHI, Ztschr. f. Hals-, Nasen- u. Ohrenh. **11**:299 (July 20) 1925.

Of fifty-three cases of Réthi, the origin of the hemorrhage was: the septum in thirty-three patients (locus Kisselbachii); in one patient, the anterior upper

portion of the septum (art. ethmoidalis); in twelve of these patients there was arterial bleeding; in four patients, the lower nasal meatus; in three patients, the origin of hemorrhage was the artery extending forward on the floor of the nose; in two patients, the artery at the middle of the floor of the nose was the cause; in one patient, the artery on the septum backward and upward; in two patients, the hemorrhage originated from the anterior portion and the posterior third of the middle turbinate; in one patient, the origin was the posterior end of the lower turbinate; in one patient, the upper margin of the choana; in one patient, from small angiomas in the nose, especially on the septum; in four patients, the origin of the diffuse hemorrhage could not be established.

Escat remarks correctly that severe hemorrhages occur principally in the posterior parts of the nose. This is natural, because the main branches are arranged in the posterior part of the nose. The ethmoidal arteries are comparatively thin and the lumen of the nasopalatinal artery which bleeds so frequently is small, the hemorrhages in the posterior part on an arteriosclerotic base are especially violent. Réthi proceeds in the following manner to establish a diagnosis. He uses a cocain-epinephrin spray. This lessens considerably the severity of the bleeding. Sometimes he uses pieces of gauze saturated with cocain-epinephrin for one to two minutes. If the hemorrhage is very severe a cold object, ice or a piece of metal is placed on the neck which lessens the hemorrhage by reflex action (Muck and Jurasz). The patient blows his nose and his head is bent into a dorsal position for inspection of the nose. Packing is used if the patient is very anemic at the beginning of the treatment, and if a longer manipulation might be dangerous, or, if a hemorrhage is so severe that an exact topic diagnosis is not possible, or if the recognized point of the hemorrhage cannot be treated successfully by galvano-cautery. If packing is indicated, it must be done without causing more pain than is absolutely necessary and with as little injury as possible. When the packing is removed there should not be a renewed hemorrhage which demands a renewed packing. Réthi uses a slender tube, 14 cm. long, with a pear shaped ending. At the proximal end are two finger rings. An obturator is used to introduce the tube. A second obturator with a forklike tip is used to introduce the gauze which is 2 cm. wide. The tube is covered on two sides with a gauze strip of a width of from 6 to 7 cm., like a sling. This gauze furnishes a covering for the tube and is enforced at the distal opening of the tube by a layer of moist gauze. When the tube is armed in this manner it is introduced as deep as necessary, the introducing obturator is removed and the tube is loaded with the 2 cm. wide gauze with the aid of the second obturator with its forklike ending. The stripe of gauze is pushed out like a sausage. This gauze rests in the covering of the tube and cannot slip down into the pharynx. If this method is used in the lower nasal meatus, the gauze covering the tube must not be wider than from 3 to 4 cm.

If the origin of the hemorrhage cannot be found Réthi thinks that it is imperative to place a packing first in the lower meatus and then to pack the nose. If the bleeding originates from the most posterior parts for instance, from a branch of the arteria sphenopalatina, a clublike tampon is formed within the covering sheath which tampon exercises a pressure on the bleeding spot. By using the covering sheath the removal of the tampon becomes easier. The cover adheres to the mucous membrane, but the gauze within can easily be removed without any pain to speak of. The gauze within the cover does not adhere to the mucous membrane, therefore there is not any bleeding as a rule when it is removed. If the covering sheath should be removed, a new hemorrhage would ensue, therefore it must not be removed at this time. Rethi prescribes an ointment, of which the patient snuffs up a quantity equivalent to a bean every half hour. The adhesions are loosened so that the covering sheath comes out smoothly the next day. The packing is left two days in the nose at the most.

REMARKS ON THE "INTRANASAL OPENING OF THE FRONTAL SINUS" BY RÉTHI. R. GUMPERZ, Ztschr. f. Hals-, Nasen- u. Ohrenh. **11**:315 (July 20) 1925.

Any method which intends to create a free communication between the frontal sinus and the nose with radical removal of the ethmoid cells rests on the necessity of the removal of the upper portion of the processus frontalis of the upper maxilla and of the crista nasalis of the frontal bone. Halle has called attention to this circumstance. The question arises which is the best method to resect the processus frontalis and to remove the crista nasalis, which gives the best view and avoids injuries in the best manner?

Gumperz answers Réthi as follows:

1. Réthi doubts the possibility to thin the bone mass, consisting of the remainder of the frontal process and the nasal spine with the chisel from backward forward, except in rare anatomically favorable instances, because the nasal cavity would be entered from without. This is not correct. At the time of the operation when the thinning of the bone mass takes place, the frontal process of the upper maxilla has been removed way up, and the space called by Gruenwald the ethmoid lacrimal space has been laid open by resection of the frontal process and the chiselling of the inner border of this space. It is then possible to thin the exposed mass of bone with chisel, burr or rasp from backward forward under exact supervision of the eye.

2. Réthi is not correct when he assumes that the nose is entered. After loosening the soft parts and the mucous membrane of the nasal middle meatus the surface of the processus frontalis and the interior of the nose are laid bare. This facilitates the topographic view and makes an injury of the lacrimal sac impossible. After formation of the flap of the mucous membrane, an excellent view of the interior of the nose is obtained. The more the resection approaches the floor of the frontal sinus, the freer becomes the view into the interior of the nose.

3. Gumperz does not consider it without danger when Réthi widens the entrance into the frontal sinus with hooks and curets. Halle rightly calls attention to the danger of even the least application of force, because the bone which lies in the immediate neighborhood at the point where the posterior wall of the frontal sinus turns into the cranial base is sometimes as thin as tissue paper or even shows dehiscences.

4. Réthi claims that the tension of the skin prevents free motility with the peroral method. It is true that this is the case to a degree, but the view with the peroral method is far superior to that with the endonasal method. Also the advantage of having both hands free and to be able to use the hammer oneself instead of letting the assistant use it, is of importance. The conditions are similar to those in dacryocystorhinostomy operations which Gumperz performed perorally for seven years for the same reason.

5. Réthi complains that the peroral method requires the removal of a longer ridge of bone than with his method. Just by the thorough resection of pieces of bone of the lateral nasal wall the excellent view is obtained, as it is not available in the endonasal procedure.

RESULTS OF THE WEST OPERATION IN CASES OF DACRYOCYSTITIS. K. L. CHILOW, Ztschr. f. Hals-, Nasen-u. Ohrenh. **11**:318 (July 20) 1925.

West mentions that 90 per cent. of the patients are cured by the operation. In 1923, Wojatschek performed West's operation on twenty-seven patients thirty-two times. (Two reoperations and three bilateral operations.) A favorable result was obtained twenty-two times (freedom from pus and epiphora). The lack of success in ten patients is explained by aggravating circumstances (deformation, inflammatory condition of the nose, pronounced

atrophic condition of the nasal mucous membrane, deflection of the nasal septum, splitting of the canaliculi, paresis of the muscle apparatus of the nasolacrimal duct, narrowness of the nose, anomaly of the constitution). The percentage of cures in the hands of Wojatschek was seventy-three. Encouraged by these results many patients sought relief. Twenty-eight cases of dacryocystitis and six cases of simple epiphora were treated. Of the cases of dacryocystitis only seven were without complication, the other twenty-one suffered from various complications, such as dilatation of the lachrymal sac, traumatic obliteration of the ducts, phlegmons, ulcus serpens corneae, fistula sacci and lacrimalis interna. Of these twenty-eight patients with suppurative dacryocystitis, nineteen were completely cured by West's operation, five were partly cured, and four were not cured. Of the six cases of epiphora only one was cured, three were partially cured, and two were not cured. Wojatschek's mobilization of the nasal septum was frequently used before West's operation was performed. Thereby a better access was reached in spite of unfavorable anatomic conditions (narrow space, deviation and crista of the nasal septum). This method is greatly recommended, especially in cases in which a free exposure and free opening of the lachrymal sac is demanded. The examination of patients suffering from dacryocystitis showed that most of them were suffering from a dry atrophic catarrh of the nose. Sohukoff showed the prevalence of atrophic catarrh of the nose during the last grave hunger years.

The ductus and saccus lacrymalis are an anatomic entity connected with the nose. The tear ducts, however, are an outgrowth of the common tract of epithelium which take up muscle fibers from the musculus orbicularis oculi.

The bacteriologic examination showed that after the West operation the diplococcus disappears. The pathogenic diplococci disappear simultaneously with the clinical symptoms of dacryocystitis. The disease of the lacrimal ducts cannot heal in from twenty-four to twenty-eight hours. Operations on the bulb must not be undertaken until the dacryocystitis has disappeared entirely. The favorable influence of West's operation on the attenuation of the virulence and pathogenicity of the diplococcus is shown in a patient who suffered from a diplococcus dacryocystitis and an ulcus serpens corneae. A perforation with subsequent loss of the eye threatened the patient. Energetic conservative measures did not help the disease. The ulcus conquered new regions and covered the cornea in the shape of a segment of 180 degrees. After the operation, the ulcer decreased in growth and malignancy concomitant with the disappearance of the symptoms of dacryocystitis. Cirincione introduced a tampon saturated with a pure bouillon culture into the opening made by the operation and left it in place for twenty-four hours. Before removing the tampon he took a smear from the conjunctival mucous membrane, and after removal of the tampon a smear from the nose. In three patients examined in this manner, microbes could only be found in the smear from the nose.

INTRACAVERNOUS INJECTIONS INTO THE LOWER TURBINATES ESPECIALLY WITH SODIUM CHLORID SOLUTION. EUGEN HOPMANN, Ztschr. f. Hals-, Nasen-u. Orenh. **11**:425 (July 20) 1925.

In 1922, Polte claimed that neoarsphenamin could be injected into the cavernous portion of the lower turbinate without injury. For years Hopmann had treated rhinitis vasomotoria systematically with intravenous injections of calcium chlorid, but he followed the experience of Polte and injected calcium chlorid intravenously through the cavernous body of the lower turbinate. He also injected calcium chlorid solution into the irritation points of the nose

anteriorily above the insertion of the lower turbinate and at the tuberculum septi. For about a year Hopmann replaced the calcium chlorid solution by a solution of a strontium compound. This solution has the advantage that smaller quantities are sufficient. Instead of 10 c.c. of calcium chlorid solution, 5 c.c. of strontium solution can be used. The mucous membrane of the nose must be anesthetized in all intranasal injections. Gauze stripes saturated with alypin are left in the nose for twenty minutes. Alypin is used because it does not contract the capillaries. The tip of the needle must not penetrate to the periosteum because then the injection would be painful. Schuerholz used this method to inject neoarsphenamin in a very fat lady in whom the veins of the arm could scarcely be found. The patient suffered from tertiary syphilis and had broken down nodes in the septum. The whole treatment for syphilis was carried out with this patient by using the left and right nasal cavity alternately. Linser claimed (*Muenchen. Med. Weekly*, No. 16, April, 1924) that varicose veins could be obliterated by intravenous injection of from 16 to 20 per cent. sodium-chlorid solution. Hopmann now uses sodium-chlorid solution. Without sufficient anesthesia the injection of from 10 to 20 per cent. sodium chlorid solution into the cavernous body is too painful. It is not sufficient to insert a tampon with a 25 per cent. alypin solution. Therefore Hopmann precedes the injection of sodium chlorid solution by an injection of a 1 per cent. procain solution without epinephrin. After from five to ten minutes, the sodium chlorid solution can be injected without considerable pain. Hopmann starts at the posterior end of the lower turbinate at three and four places and uses from two to four c.c. in each turbinate. At the points of injection a rather continuous bleeding occurs on account of the hemolysis caused by the sodium chlorid. For this reason a small tampon must be introduced into the nose for several hours. Rarely a scab forms. Sometimes a covering of fibrin is found on the turbinates for several days. Hopmann treated fifty patients in this manner. If the hypertrophies are firm, the injection of sodium chlorid solution is useless. Those turbinates must be treated surgically. Patients with very pronounced hyperemic swelling in whom also the skin of the face is continuously reddened and who show also a hypersecretion of mucus on a vasomotoric base cannot be influenced lastingly by injection. Those patients can be treated advantageously in whom one side of the nose is occluded at the time, whose mucous membrane contracts well after application of cocain-epinephrin, and who breathes more freely for months after cauterization with chromic acid. Compared with cauterization with chromic acid or by galvanocautery, the injections with sodium chlorid solution have the advantage that the reaction disappears more quickly and that the surface of the mucous membrane is spared. The exact proof that the ciliated epithelium is less damaged than by an extensive cauterization of the mucous membrane must still be furnished by histologic investigations.

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EUGENE A. CROCKETT, M.D., *President, in the Chair*

(Continued from page 320)

TUESDAY, MAY 5

(Discussion on papers by Drs. Beck and Mosher, presented at previous session)

DR. GOLDSTEIN: It occurred to me when making observations of a more technical character, and when I read, about sixteen years ago, of the cosmetic work in surgery of the ear, that most of these defects are really concerned with the external ear and canal, rather than with the middle ear and cavity of the labyrinth. I think there might be come anatomic explanation in this disparity of the anomalies. The labyrinth, ossicles and annulus are in the bigger centers of ossification of the body and at birth they are fully grown bone structures, that is, at birth they are in the same state of development as they are in later life. External deformities are developed before birth, and these engage the attention of investigators much more frequently than those of the labyrinth and middle ear.

The inference which may be drawn is the determination of whether the end-organ of hearing, or the central auditory field is affected in a given case with profound deafness. In those of our researches which have been done along the line of development of residual hearing, we have found that when we can make that differentiation that, as regards future development of our work, that when the end-organ has been affected in an animal of this kind and the central auditory field is apparently intact, that these represent the cases in which residual hearing shows the best promise of results.

We are attempting to make fairly accurate tests of all the cranial nerves in every deaf child with the hope that we may determine something more definite as to the site of the pathologic lesion. If you have the other sensory nerves about the brain stem, reacting fairly normally (all other things being equal), it might be fairly definitely assumed that the auditory nerve, which lies fairly close, is also normal and that we must look for the pathologic changes in the end-organ or the cortex, but not in the brain stem. We find that if we have smell or vision involved, that we might conclude with some logical basis that the auditory nerve is also involved at the brain stem, because the location is so closely associated with that of the other sensory nerves. Dr. Beck showed a number of cases with involvement and paralysis of the facial nerve with this abnormality. It might be inferred that the paralysis of the facial nerve occurs anteriorly, in the aqueduct along the sternomastoid foramen, rather than in the internal canal. If I recall his remarks, the hearing was fairly good. In the two papers facial paralysis was due to anterior deformity about the foramen or aqueduct. Another significant fact is that the anatomic deformities are rarely associated with total deafness. This in itself is a guide to the investigators and pedagogs in their work on the deaf child. In this class of cases there are many interesting possibilities of investigation that it is difficult to draw any limitation.

DR. PIERCE: I think the embryology has especial significance and importance in the study of these cases. Dr. Goldstein said that he has investigated the cranial

nerves other than the eighth, with a view to ascertaining the state of function of the surrounding nerves, and concluding therefrom the possible function of the eighth. I do not believe that conclusion would be supported by embryology because the eighth nerve, especially the labyrinth, is so peculiar in its embryologic formation that it is utterly differentiated from the other cranial nerves. The otocyst exists at a very early age when the embryo is only a few millimeters in length. This otocyst is an invagination of the ectoderm, and for a long period is isolated in the mesoderm. Of course the whole brain structure is an invagination of the ectoderm, but it remains open for a much longer period. The otocyst is invaginated and closed in at a very early age, long before the formation of the other cranial nerves. It is important to remember that the eustachian tube is from the endoderm and is preformed as it were, because of the duplication of the first branchial pouches, which are the first structures which occur in the differentiation of structure; whereas the external auditory canal is derived from the ectoderm much longer after the invagination of the otocyst is complete. As we have to have a meeting of the ectoderm from the pharyngeal pouch going in and the endoderm going out, only the mesoderm is left, which forms the circular and radial fibers of the middle ear and tympanic membrane. It is therefore difficult to draw any conclusion as to the cranial nerves other than the eighth in relation to the function of the eighth.

I was interested to note the extensive pneumatization in one of the cases. I think that that is the best lead that the operators can have as to the functioning of the eighth nerve, because we know that pneumatization of the mastoid takes place largely at birth, and that it must occur from the mesenchyma tissue present at birth, invading the marrow spaces of the mastoid process. I would say that if we have pneumatization of the mastoid we have middle ear structures. It may be that the middle ear structures are deformed, that there are certain ankyloses that occur in the sound conducting apparatus, that would interfere with hearing, but with pneumatization we have direct evidence of a perfect sound conducting apparatus. If this is so, again we must be careful of drawing very strong conclusions because the stapes grows from cartilage of the second branchial arch, while the malleus and incus are derived from the first. There is a possibility of nature getting mixed up at this point of development so that deformities might occur between these structures that would render the sound conducting apparatus nonfunctioning so far as transmission of sound is concerned.

Dr. Thomas J. Harris, New York: I was particularly impressed with what Dr. Beck said about the psychologic results of these conditions. All that he has said is perfectly natural, but we have not been sufficiently impressed with what would naturally take place in the patients and in their fathers and mothers. There must be a tremendous psychologic improvement, as he has described. I agree with Dr. Goldstein that as Dr. Beck reports his results, with others later, that more men will take up the work which he has been doing. Until recently, we have felt that it was not possible to be done, also that it was not necessary. Dr. Beck has pointed out the necessity. The Otological Society should have a genuine pride in Dr. Beck's work. We all realize the discouragements of this work, because many times there is apparent failure. I hope that he will continue because of the tremendous change brought about in the patients and in their parents, even when the work is not completely satisfactory from the otologist's standpoint.

Dr. I. Friesner, New York: With regard to the time of operation, these cases are divided sharply into two groups phylogenetically—those of the external and those of the internal ear. The first group is purely external. In the second the alteration of the internal ear is clearly defined. It is apparent that the reasons

for operation in these two groups must be different. In the first there is correction of the deformity, in the second improvement of the hearing. It would be worthy of discussion to determine at what age one should operate. If one depends on determination of the hearing, the operation could be scarcely undertaken before the age of 5 or 6 years. I doubt whether one could make accurate determination of hearing at 18 months old. At what age does Dr. Beck think it possible to operate and how does he determine between the two groups?

DR. SMITH: Does Dr. Beck attempt to make an artificial auricle? I have in mind numerous cases without any auricle except a malformation. Secondly, given a case in which you form an auricle, you often have an atresia of the external canal. Would it be possible in a case of that type, with some hearing, to open the canal, and what is the method of keeping the canal open? I have tried this in a few cases, but I have never been able to keep the canal patulous. The canal tissue forces out the tube.

DR. DENCH: I tried to form an auricle once, but it was a hard task and I have never tried it again. We know from the study of the specimens of these cases after death that when the auricle and canal are malformed, the deeper parts are never well formed. The canal is often not present, and the middle ear is malformed. Even when there is a tympanic cavity, it is very fractional. The cochlea is defective and the auditory nerve is imperfect. There seems to be very little encouragement in operating on these patients. I did get a fairly good auricle two years ago. I attempted to do what Dr. Page did and opened the tympanic cavity through the mastoid process. It was in a young child and the roentgenograms were not satisfactory. I found no canal, and no middle ear. I did no damage, but I did no good. I would like to hear Dr. Beck explain his methods.

DR. CROCKETT: I had an experience a year ago which answers Dr. Friesner's question as to a new-born child. There was a partial auricle. There was no abnormality of the skull, face or jaw. I waited until the child was 3 months old and had developed a normal mastoid process. I then operated to restore the canal as a preliminary measure. I went in by the proper anatomic path to the canal. I packed the canal and then put in a Thiersch graft, and made a patulous canal half an inch deep. The interesting point is this, four months after operation the canal was patulous, but the child during the influenza epidemic developed acute otitis and had a normal discharging ear on that side. If I had waited, the patient would have died.

In a rolled and twisted auricle, in which you attempt to restore the canal, the canal lies back of that auricle; if you attempt to go in front you will go into the joint of the jaw. In one case I came within a hair's breadth of getting an ankylosis of the jaw.

DR. DENCH: Did you find a drum membrane when you formed a canal?

DR. CROCKETT: There was a middle ear and tube. I thought that when the child was older I would go from that point inward.

DR. RANDALL: In view of the development of the external ear in the cartilaginous nodules, I have a feeling that in the cases of congenital malformation during the prenatal period there is a general inflammatory binding down of the nodules which gives rise to the deformity. I have regarded the condition as parallel to the bound up feet of Chinese women. In loosening this inflammatory mass of adhesions which prevents development of the nodules forming the internal canal, we give an opportunity for the development of the auricle. I have seen confirmation of this in a few cases. The external semblance of an ear is formed

as a rudimentary ear. I believe this idea is not erroneous and could be carried to a more successful issue. The amount of hearing with a malformation is sometimes surprising. Perhaps the patulous eustachian tube can serve to carry sound waves more than we anticipate. As to the maintenance of a patulous external canal, previously opened and grafted, I have obtained the best results by a use of a small screw with a rolled up cylinder to slide. That we can expand with the forceps and it will overcome the tendency to the reformation of the stenosis and keep the desired opening. This is particularly true in adults, in whom we have had cicatricial stenosis from massive burns.

DR. BECK: I think Dr. Friesner's question is very appropriate, first as to the time to operate, and second, as to the differentiation of the two groups. We must also consider the psychologic grouping. This was my point in operating, and Dr. Harris has emphasized this factor. This is an operation for the minds of the parents, as well as for the patient, because they as well as he, feel his inferiority. As regards the two groups, whether the ear is deaf or not is important. Now we have methods to determine the vestibular apparatus and we can tell whether we have a functioning ear or a partially functioning ear. There are many difficulties; it is not merely working with connective tissue. You will be disappointed through the contraction. You do a mastoid operation, that is, removal of the posterior canal wall to avoid injury of the glenoid fossa, which will occur if you operate behind the auricle. We have found cases of congenital deformity, but I do not think it is usually considered inflammatory. The point is to do the work early so that growth may give development. I do an early operation to loosen up the parts for a primitive pinna, and get ready for a later operation. A flap from the neck can be used in future work. You can determine whether the middle ear is dangerous by passing a bougie. The indications for pneumatization are correct as regards the mastoid and middle ear. I am sorry no one touched on the relation of pneumatization to hearing. Concerning results, in one case after many operations the result looks something like an ear. I used cartilage from other parts, also a thin ivory plate to stiffen the roll of the ear.

A CLINICAL STUDY OF BONE CONDUCTION AFTER THE METHOD OF RUNGE. Presented by DR. JESSE WRIGHT DOWNEY, JR., Baltimore.

Most otologists believe that there is such a thing as normal bone conduction, that is to say, that a vibrating tuning fork should be heard when its stem is pressed against the head for a length of time which does not vary greatly with one particular fork in any number of persons. It has never been definitely determined whether bone conduction is simply the perception of those sound waves which pass through the sound conduction mechanism (Bezold), or whether there is a direct craniolabyrinthine transmission (Wittmaack and others).

In 1923, H. G. Runge published a study of bone conduction and described his "water-filling" test, which is simply the timing of the duration of bone conduction with the stem of the fork over the mastoid before and after filling the ear with 1 c.c. of water. In the normal ear or in the pathologic ear with a normal drum and ossicular chain, bone conduction can be doubled by the "water-filling." The test has been repeated in a series of cases and the same results obtained. Runge, however, explained the reaction by claiming that increased bone conduction was caused by a better conduction of sound waves through the fluid. This apparently has been disproved and the theory is offered that the increase is occasioned by a change in position of intralabyrinthine structures brought about by the pressure exerted on the foot plate of the stapes and the compensatory action at the round

window. The Runge test also makes it possible to study artificially produced Weber and Schwabach experiments and suggests the possibility of estimating the bone conduction of one ear alone. The experiments offered are purely clinical, but the observations offered suggest that there is a direct craniolabyrinthine transmission of sound vibrations, and that bone conduction is an entity which may be separated from physiologic air conduction, thus making the universal tests by bone conduction of more value in differential diagnosis.

DR. SONNENSCHEIN: It has always seemed to me that when any procedure of modification of previous tests or manipulations becomes popular, it is the duty of otologists to investigate these methods to see what light can be thrown on their diagnostic possibilities. With reference to Bezold's bone conduction work, in regard to the theories that all sound waves must come by air to the tympanic cavity before they can be appreciated by the labyrinth, either by flat surface, or by striking the edge of the bone, I am not in a position to discuss this question definitely, being neither physicist nor physiologist. We do know that the tympanolabyrinth route is better, and air conduction is heard longer than bone conduction. The ossicles are supposed to change great amplitude with small force, to small amplitude with great force. You can get this conduction when the ossicles are gone, however, except the foot plate of the stapes. Bezold believed this to be true in sounds by air conduction. If you have a tympanic cavity without ossicles, sounds going in at the head will cause great vibration of the stapes. In using the low forks for bone tests, I doubt whether we ever use a fork below 100 double vibration, though I cannot state that definitely. I think that the study of bone conduction offers a key to diagnosis and prognosis of the ear condition. Politzer said that prolonged bone conduction is a good prognostic sign, but he forgot that in otosclerosis that prognosis of hearing is poor. If you have obtained bone conduction entirely, the ear is functioning well. Dr. Downey showed that in the Schwabe test there is marked difference in bone conduction by the mastoid and by the forks. The odds are three to two in favor of the mastoid. Work with the Rinné test showed that transmission of sound by bone conduction from one side to the other is as in the infinitely negative Rinné, that is, the sound is transmitted from the diseased side to the normal side. Bone conduction is transmitted to the intralabyrinthine structures with compressor action at the round window. The weight of 1 c.c. of water is very slight, but we know that if we use considerable pressure and force the ossicular chain inward, we get reduction of the opening, by bone and by air conduction because the free mobility of the stapes is diminished.

I believe that the principles involved in the Rinné tests are similar to placing the finger in the external auditory meatus to see if the bone conduction can be increased. If the bone conduction is already long, there is no reaction, but in the normal individual, when it is not long, there will be a reaction. In determining definitely what the value of these tests will be, various amounts of fluids of various weights and pressures should be tested. I believe that if Dr. Downey and others will investigate these tests further, it will throw great light on our methods. There is no question of the truth of the principle that the cooperation between physicists and otologists will aid in solving the problems involved in audition.

DR. FOWLER: I have been making a series of experiments in bone conduction for the last few months. Before reading Dr. Downey's paper, I had made experiments on bone conduction by filling the ear with different substances, with pus in the ear and also by closing the ear. Closing or filling the ear with water causes several phenomena: first, it loads the conducting mechanism; second, if

the mechanism is abnormal in the first place, the extra load by closing the ear by water will not be appreciable as in normal cases; third, by closing, or by filling the ear with water, you cut out external sounds that interfere with hearing with the ear open; fourth, there is a tremendous increase of the bone vibration, because they are transmitted to the fluid in the ear or to the ear closed by the finger, and thus to the drum membrane, much more than to the drum membrane without filling the ear with fluid; fifth, increase in bone conduction by these methods depends largely on the fork used, on the frequency, on pressure, on the stapes diminishing the loudness of the bone conduction sounds as in the Gilet test, in which the higher frequencies sometimes increase bone conduction; sixth, if the ear is filled with water and you make pressure on the fluid, and thus on the drum, ossicles and stapes, you get diminished sound bone conduction instead of increased bone conduction, so that the Gilet test may be used with as well as without water in hearing tests.

In loading the incus and malleus the membrane will stabilize the middle ear mechanism. It will have more inertia. Therefore sounds coming in by bone conduction, shaking all the structures of the skull will act more forcibly on fluids contained in the labyrinth with a loaded mechanism than they will with a lighter mechanism. Hence filling the ear with water in various tests will cause greater impulses to be transmitted to the skull than with the lighter mechanism. I think that is the explanation.

So far as frequencies depend on this, each fork will vary from time to time and under various conditions. I have tried many experiments on different people, and they bear out what Dr. Downey has said, but my forks are different from his. With a 256 double vibration fork I get about one-third increase, not double increase. The normal varies in bone conduction with forks and with frequencies so that one or two tests mean very little. They may be different. The patient must be educated to concentrate and give definite answers. I made at least 10 tests on every case and averaged the tests. The data are on average tests. The response in the radicals was nil. There was no Rinné phenomenon in increase in bone conduction. I tried otosclerotics—there was no increase. In catarrhal deafness there was slight increase in some cases and no increase in others, owing to differences in the mobility of the ossicular chain.

Whether you activate the labyrinth fluid through the air conducting mechanism, or whether you perform a caloric test and shock it, you will get the same characteristics brought about with the mechanism of the basilar membrane. If the 1,000 double vibration selects the middle of the cochlea for the point of greatest vibration, then you shake the cochlea as physicists do in their laboratory, that same area will be more activated, just as if you do it through motion of the stapes. Physicists believe that is the case. All the apparatus they have acts the same way, therefore, a perfect piece of apparatus like the cochlea acts the same way.

In normal ears you may increase bone conduction and obtain a variation of from five to eighteen seconds from one examination to another. Therefore one or two examinations would not give accurate results. We must make a large number of examinations to be sure of the figures.

I tried to perform experiments by putting wax in the ears, but I was afraid to carry this far. Fortunately a patient came in who had been told to put hot oil in the ear, with the result that there was complete block of the canal. That lateralized the Weber test to that ear. The other ear appeared to be normal. By closing the good ear we lateralized the sound to the other ear. In an ear filled with parafin this was not so apparent as with closing of ear on the other side to lateralize the sound. I think the reason that the Weber test is lateralized well

in one ear is that you have two identical sounds in both ears, and one sound masks the other. You have a masking experiment. The sound either masks or does not mask the sound.

DR. HARVEY FLETCHER, Chattanooga, Tenn. (by invitation): There are one or two points which should be brought out. The question of bone conduction is not a simple matter. I have always felt that the conclusions generally believed in are on shaky grounds because of the complex nature of the problem. There are a great variety of conditions which occur before sound goes into the ear. I have heard one point mentioned as a fact, and that is that when bone conduction is increased, that the path by bone in the middle ear is a better conducting path. That does not follow because you can hear the fork with the handle on the bone. You cannot tell which path is better. If you put the tuning fork on the table it sounds louder because you have the whole table vibrating, and you get a great deal more air stirred up because more energy is being put into the air. Physicians have asked me why we cannot make a bone conduction receiver. That does not follow. You can make an air conduction receiver for people with increased bone conduction if you put the same amount of energy into the air as they need in the bone. If you try to make an air wave go down into the water you fail. If you put your head under water and have someone talk on land, you cannot hear. The sound will not go from a light medium such as air into a heavy medium such as water. If you sound a tuning fork in the air it is inefficient, you must use a good transformer. One way to do that is to put it on bone, but bone is a poor transformer. Another point is this. Dr. Fowler said he found bone conduction increased one-third, and Dr. Downey found it double. They seemed to infer that it was an apparent discrepancy in the results, but that is not necessarily true. It depends on the tuning fork; one fork will give you double, another one-third increase in sound. Yet still the increase is the same. If you know the constants of the tuning fork, the vibration and the damping factor, you can reduce the results to mean the same thing. You must express the difference in time, not the ratio. You have to get the results on a comparable basis by getting the damping constant of the fork as well as the vibration.

There is considerable psychology involved in these tests. If you produce two tones you get beating sounds into the ear. If you put two sounds into each ear you will get a swinging back and forth in the head. When you decrease the intensity in one so that that sound will go over into the other ear you will get the beats again, due to the mixing. The subject will tell you that he hears the beats in the opposite ear. The larger intensity must be sent over to the opposite side. People refer them to the ear in which the phenomenon does not take place. The question involves a psychologic reaction, the phenomenon is in one ear, but the attention of the subject is concentrated on the other ear. That must be kept in mind in interpreting results.

MR. R. Q. WEGEL: Dr. Downey used the same method as we use in the study of acoustics. In determining the physical characteristics of the apparatus, the method is to set it in vibration and measure the response and then add certain known factors of weight or tension which we can compute. You can postulate some sort of mechanism and compute what the effect will be. If you get the results you expect, the mechanism behaves as you expect. The mechanism of the ear with bone conduction is complicated. There are many ways in which bone conduction can occur. It does happen in many ways, but only one controls, the question is, which one? If you listen to the tuning fork by bone conduction, and then by air conduction, you hear the same pitch. On all mechanical theories of hearing the differentiation of pitch occurs mechanically in the ear, and means that

the same pitch must take place by air as by bone conduction. The theory on which we have been working, is a relative motion of the basilar and tectorial membranes in spots determined by pitch. The 256 double vibrations get a point on the basilar and tectorial membranes 27 mm. from the round window. If you hold the tuning fork, it means that the same relative motion of the basilar and tectorial membranes must take place. That is an interesting point—any theory of hearing must explain how you get the same vibration by air as you do by bone conduction. It means that the labyrinth is very snugly contained and that no matter how you agitate it, the same kind of vibration must take place. We have had objections made to using receivers by air conduction. People think you get bone conduction by receivers, but you get bone conduction from the air. The head, the bones of the body, the floor, the walls, are all quivering in response to the voice. You can calculate how much that is in contrast to the ear drum.

If you take a massive piece of steel, the sound is reflected at the surface of the metal, but some is transmitted by molecular transmission to material. You can figure out how much less vibration there is in the metal than in the air. It is 35 sensation units less. If you had a mechanism which you can place in a solid mass of steel, which can pick up vibrations from the steel, as the ear does from the air, you would only lose one-third from that area. We calculate these constants from bone and flesh. It is 35 sensation units. That is less than steel, but steel is an extreme example. The finger tips are sensitive to sound and air vibrations. If the internal ear mechanism is not constituted in the bones of the head to make an efficient pick up mechanism for vibrations that come into the bone, assuming that by bone conduction you get only one half of the area, it means that the ear mechanism as a tactile sense is as much more sensitive to the vibrations of the bones of the skull with the help of air contact, as the normal ear is compared to the unaided mechanism of hearing. Mechanism by bone conduction is an extremely efficient piece of apparatus, even if you had no air conduction at all because the vibrations are picked up out of the air and picked up by the bone by being shaken. Dr. Downey does not think that vibrations are transmitted through the liquid placed in the meatus. This is reasonable on physical grounds. By bone conduction you have shaking of the mechanism, and the fluid in the labyrinth tends to stand still, so you get some kind of relative motion in which the fluid is moved and the head stands still, therefore, bone conduction is more like the tail wagging the dog.

In regard to the Weber test, we can explain that by another method than by increased volume of sound going to the closed ear, but it is possible to get localization on this side without that. Stimulation of the basilar membrane will give an action current of the nerve, but in the other ear it will arrive later than in the first ear. The two nerve trunks, as I understand it, unite before reaching the brain centers. The two sounds must therefore unite also. It is also an experimental fact that if you take one nerve trunk and stimulate it by two impulses, you will get two action currents traveling, but when they get close together and overlap, the next one will become subnormal, and the next one will not affect the nerve at all. In the transmission which takes impulses to the brain, although you get impulses from both ears, sensation is due to the one that gets there first. That is one possible explanation, but I think probably the other one is correct.

Dr. Downey: I am perfectly satisfied to sacrifice my efforts if we can get an explanation. I have simply exploded theories which are not tenable. I have read Bezold, but I think that in dealing with vibrations of low frequency we have to accept the theory that the vibrations must come through the ossicular chain.

We do not know that the ossicular mechanism is necessary to the high notes. Reduction of a second or so with high forks means profound deafness, but with the low forks it does not mean anything. After a radical operation, high notes are well heard. If we find diminution of a second with them it is normal, but it is profound deafness for that tone. With 64 double vibrations it would not mean nearly as much deafness. I have tried out Dr. Fowler's tests on some patients and I tried also to get a fluid with the same volume, but with greater weight than water; I have not carried the experiments far enough to submit at this time. When it comes to the discussions of Dr. Fletcher and Mr. Wegel I cannot discuss physics with them, but I believe that we can test these matters by simple clinical methods which will give us much clinical information.

RESULTS IN RADICAL MASTOID OPERATIONS AS TO HEARING. Presented by DR. HAMMOND.

In transmission of sound waves to the auditory nerve there must be no impediment to vibration of the ossicular chain. The movement of the perilymph is necessary to nerve stimulation. After a radical mastoiditis, too often granulations and discharge encroach on the middle ear and become epidermatized. The organs of hearing are effectually sealed. If large formation of connective tissue occurs after skin graft, the result is the same. Another cause for damage of hearing is the persistence of raw, discharging surfaces in the middle ear. I have found from experience with patients that when the sound perceptive apparatus is intact, the clearing away of débris will restore good hearing. I have had many cases with fortunate outcome and great improvement of hearing; if care is taken in the radical mastoid operation to prevent impediments to stimulation of the nerve, these patients can recover and remain well and will have a degree of hearing which is highly satisfactory to the patients. Of course, we also have our poor results.

CHOKED DISKS IN ASSOCIATION WITH SURGICAL MASTOID DISEASE WITHOUT APPARENT INTRADURAL INVOLVEMENT. Presented by DR. LILLIE.

The association of choked disk with surgical mastoiditis may be considered an important sign of intracranial or intradural infection. It has been noted, however, that choked disk may occur with surgical mastoiditis without other evidences of extension.

Intracranial infection is not as serious as intradural infection, because the dura is highly resistant to infection while the brain substance is not. It is wise, therefore, in cases of surgical mastoiditis with choked disks, that careful studies be made and that no attempt be made to interfere with the brain substance until evidence of intradural invasion is certain. While the incidence of choked disk in surgical mastoiditis without intradural extension is low, it is sufficiently frequent to be considered in the differential diagnosis.

Clinically, four cases of the latter finding have been studied in detail. The patients recovered completely. There was no conclusive evidence of intradural extension, although it was not definitely excluded. Three patients had parasinus abscess, the fourth showed pachymeningitis, and a large cholesteatoma pressing on the sinus and cerebellum. In one patient intradural exploration was made without result. The mechanism of choked disk in such cases is a moot question. Unless we have strong evidence of intradural infection, exploration of the brain is not warranted. The fundi oculi should be examined in all surgical mastoid cases.

DISCUSSION OF PAPERS OF DRS. HAMMOND AND LILLIE

DR. PIERCE: In regard to skin grafting, I used a special graft during the war, cutting a piece of skin from the postauricular region, anchoring it into the eustachian tube by a piece of suture. I have used twelve methods, and in each case the tube has closed. The flap has held except in one tubercular child. The flap does epidermize the cavity, but it takes longer in operative time. The technic is necessarily rather complicated, but it is within the reach of every operator accustomed to operate in this region. I have never done primary graft such as Dr. Mosher recommends so I cannot speak with any authority. My assistants have attempted it, but perhaps with faulty technic, for most of the grafts have sloughed. As to the effect of radical operation on hearing, it is remarkable how few thorough examinations are made before operation of suppurating ears. This is a great error. Not only should the cochlea be examined, but the static apparatus should be examined thoroughly before operating. This gives important data afterward, in case there is involvement of the labyrinth, unsuspected before operation. It tells whether there is degenerative disease of the nervous apparatus before operation, or whether there is stapes ankylosis. With these data at hand, I should say that the radical operation does not increase or decrease hearing. We may have a decided degree of hardness of hearing, but this may not depend on the stapes ankylosis, it may depend on the fixation of the malleolus and incus, or by adhesions in the oticus. There may be increase of hearing after operation. If there is stapes ankylosis there will be no increase in hearing, as in stapes ankylosis from any cause. Therefore I wish to emphasize the importance of a thorough functional examination before operation for suppurative ear disease. I believe you will agree with me that the operation does not change the hearing with stapes ankylosis but in cases in which the hardness of hearing is due to other causes, when the stapes is not fixed, the deafness is due to fixation of the ossicular chain. Then what happens? I think when the stapes is not fixed that deafness does not occur for many years after operation. It seems incredible, but I have found patients in whom inflammatory fixation of the stapes has not occurred, and hearing has remained intact even with the protection of the tympanic cavity removed, fifteen years after operation.

DR. DUELL: In the early days when we understood the radical mastoid operation, our hope was to rid the patient of a condition which was a menace to his life in the majority of instances, or we tried to get rid of a chronic otorrhea which was very distressing to the patient. Patients were told that the operation was not for the intention of improving the hearing, but to relieve a surgical menace. As the operation progressed and we recovered from the fear of facial paralysis or labyrinthine involvement as a result of the operation, we decided that these catastrophes were due to faulty technic. We began to discover that many of these patients, if the healing had been ideal, had improved very much in hearing. So we began to look for improved methods of accomplishing the ideal condition which Dr. Hammond has brought out in his paper. It is necessary to call attention to the importance of securing ideal excavation with sufficient room between the facial ridge and the tympanic roof. Treatment of the hypotympanum and the effort to secure a closed eustachian tube which have become axiomatic, form part of the problem in these cases. All of you, speaking from case records, could produce case for case which would equal the results of which Dr. Hammond has spoken. There are also the Class B cases, many times more numerous than those with ideal result, in which the hearing is not improved so much, but still decidedly improved after operation.

There are also many patients in whom the hearing has not been improved, perhaps it is even a little worse after operation. You have to content yourself with the fact that operation has relieved the patient from the surgical menace. Nevertheless, the importance of these cases is the striving toward the ideal to which Dr. Hammond has called our attention, and any method by which that can be accomplished should be undertaken. Twenty-five years ago, Dr. Dench and I went to Europe together, and saw Jansen doing his secondary skin grafts with a small piece of epithelium. We saw Balance doing his large grafts, and we at once obtained an outfit of instruments and raced home to perform similar operations. Dr. Dench has been the ardent exponent of the primary large graft ever since. I did a number of these cases also, but practiced Jansen's method and secured good results in many cases, but, finally, like many other operators I abandoned the skin graft except in exceptional cases. I get results just as good or better than with skin graft, and I see no reason why we should not attempt new methods.

Dr. J. G. Dwyer, New York: There is great confusion between the optic neuralgias, choked disk and papilledema. Optic neuritis is inflammatory. All of the other conditions are due to pressure. Most of the cases that Dr. Lillie mentioned would come under the classification of intradural pressure. Most of them were perisinus abscess but in cholesteatoma we do have localization of pachymeningitis or serous meningitis with referred pressure in the posterior fossa; we get eye changes with this, but that is no indication for opening the dura. I would like to emphasize the point about not opening the dura unless we are sure. I think case after case is lost by opening too soon. Three weeks ago I saw such a case which would have lasted much longer. The effects of pressure, as intradural edema of the optic nerve, can be cleared up in twenty-four hours with the evacuation of a perisinus abscess. I will mention one typical case I reported two or three years ago. This man had a mastoid abscess and then a perisinus abscess, but he would not come in for operation. Twenty-four hours before operation he had blurring of the optic disk and the left sinus was covered with granulations. We left it alone. Immediately after operation the eye findings cleared up. Five days after he had a sudden chill, then a temperature of 106.5 F. He had a sinus thrombosis. This disappeared next day. He had a positive blood culture with hemolytic streptococci in June. In August he had a blurred sensorium. He went through all the changes in blood counts from 16,000, then 15,000 white blood cells, and so on. Then in August he had brain symptoms, but not localized. In October he had choked disk and the symptoms were worse on one side. After we were reasonably sure where the abscess was located, we evacuated a large temporosphenoidal abscess, and put in a rubber tube to the brain with a suction apparatus twice a week. The man recovered. If you stress intradural or extradural, I think you can make a good diagnosis, but if your diagnosis is simply pressure, the cases are not so easy.

Dr. Wells P. Eagleton, Newark: Dr. Lillie's paper gives the impression that we can have a choked disk without intracranial complication. That, in my experience, is fundamentally wrong. If he had said a "complication that will get well without opening the dura" that is right. There is a disease we do not recognize, arachnoiditis. That will make the production of the cerebrospinal fluid so great that it will give choked disk. I have seen seven diopters produced. It may go on to suppuration or it may not, but every case in my opinion that shows a choked disk should have the dura opened. If a little nick is made, a tremendous quantity of spinal fluid will emerge. The fluid above the tentorium is infected. The fluid by lumbar puncture is not infected. Second, he said that these visual

defects were not common in abscess of the brain. If you look for hemianopsia, it will never happen, but if you take the fields you will find there is a defect in the upper or lower quadrant; it is easily indented. This is most important in the early diagnosis of temporosphenoidal lobe abscess.

DR. LILLIE: I did differentiate between intracranial and intradural extension. All these cases had intracranial, but not intradural extension. The meninges were involved, as described in the paper. Dr. Eagleton misunderstood me when he spoke of the temporosphenoidal lobe. The visual changes were not so common. We had seventeen cases—eleven with choked disks, five with normal fields and four with abnormal fields. From the neurologic standpoint they were all positive. In the four cases reported here there were no neurologic findings.

SOME NEW METHODS AND APPARATUS FOR TESTING THE ACUITY OF HEARING AND THEIR RELATION TO THE TUNING FORK AND WHISPERED VOICE METHODS. Presented by DR. FLETCHER.

A method of reducing speech, whisper, watch tick, coin click, acoumeter and tuning fork tests to a common basis of comparison is given in the paper. The relation between hearing losses in sensation units and maximum distances for hearing is given with illustrative examples. It is shown that the normal distance for hearing and interpreting a voice of average intensity in a quiet place is about 1,300 feet instead of 40 feet as sometimes assumed.

It is shown that tuning fork data may be reduced to a common basis by the relation that the percentage of hearing loss is equal to a constant of the fork, multiplied by the difference in the hearing times for a person of normal hearing and for the person being tested. Typical results are given for three groups of tuning forks.

Three types of audiometers were described and their operation was demonstrated, namely, the phonograph types for making speech tests, the buzzer tone types for making a quick test of the general hearing level, and the tone range types for making audiograms to be used in diagnosis.

Results of hearing tests made on ten patients having hearing losses from 0 to 100 per cent. taken by the various methods discussed were given. A comparison of these results leads to some interesting conclusions concerning the merits of some of the different kinds of hearing tests.

A simple method of calculating the hearing loss for speech from the audiogram taken with the tone range audiometer was given.

THE POTENTIALITIES OF THE AUDIOMETER. Presented by DR. GOLDSTEIN.

A study of the requirements for audiometers in regard to operation and utility includes: a tonal range of 16 double vibrations to 24,000 double vibrations, or full limit of normal audition. Tone intensity, an increase in intensity to 200 dynes is required in testing the profoundly deaf. A bone conduction receiver is recommended to carry out bone conduction audition tests. Uniformity of records and methods of charting is one of the most important features of the work. The Western Electric Company's chart is practical and dependable. A plea is made, urging the adoption of this scheme of charting. In tone intervals, it is urged that a seven step instrument be used, instead of a one or two step, in order that more accurate information may be had as to tone islands and tone gaps.

Practical Application: Conduction deafness was shown on the chart as a reduction in perception of the lower pitched tones in the hearing range. The high pitched tones will approximate normal. Perception deafness showed a

diminished appreciation for the high pitched tonal range, the upper range being curtailed. In normal persons after the age of 50 there is reduction to sensibility to the upper tone range. Otosclerosis shows reduction of sound perception for the entire tonal scale, with absence of tone perception for 32 double variations and sometimes sixty-four double vibrations of the lower tonal range, and also absence of perception for 8,192 double vibrations and even 4,096 double vibrations in the upper range. In congenital deafness we can test residual hearing in profoundly deaf persons. The human voice lies between 300 double vibrations to 3,000 double vibrations, and a child lacking perception for this is unfit for education by voice or instrument. In tone islands, there are gaps for hearing certain portions of the scale, and most frequently above the upper limit of hearing for the human voice (4,096 double vibrations) about the end of the middle whorl of the cochlea. This opens an interesting question for research.

DR. MACFARLANE: I would like to second Dr. Goldstein's appreciation of what the telephone engineers have done for us. Dr. Guttman and Dr. Dean have called on the physicists, and Dr. Jones has called on the Pacific Coast men, because we do not know enough about acoustics to handle the subject alone, but we can work along with them to supply the practical end. First, as regards the voice tests, we have realized that the voice test is of little practical value, we cannot control our voices exactly. This phonograph method is of great practical value in making surveys. I think it is the best method for making surveys of school children. We have found it very rapid. It gave excellent results and everybody was pleased. There are certain points in regard to the audiometer which might be mentioned. First: How pure are these tones as compared with tuning forks? I think these tones are as pure as the best forks. I have not tried it with bone conduction receivers and I am not as optimistic about bone conduction as about air conduction. In air conduction tests the amount of bone conduction is so small as to be negligible, so that this criticism can be ruled out. As regards the strong tones, these might affect the normal ear and we must be careful, but we are not going to test strong tones, we are going to get threshold stimulation. You can cut down the tone image for any tone, or even from the tuning fork. If you leave the tone on too long you will influence the result. The patient will not know the end point. You must watch for fatigue and for tone image. The noise in the room is a great deal cut down by the proximity of the receiver to the ear, but it is a factor and mistakes will be made quite often. You will think that the scales are wrong. The normal is too high; but if you get a quiet room you will find that instead of readings coming down to 20 it will be between 10 and normal, so that the scales are accurate. This composite tone type instrument is accurate and it was found very good for testing in schools. Dr. Goldstein mentioned follow-up treatment; we have not given enough attention to that, perhaps from lack of intelligence, but we have not been able to follow improvement of hearing from our tests. The complaint is made that these tests take too much time, but the same is said about the use of tuning forks. If you do these things intelligently you are not wasting time. You do not have to repeat them every time the patient comes in. Audiometer tests are much more rapid than careful tuning fork tests. The instruments require intelligence but they are as fool proof as can be made. Of course they are not free from the necessity of intelligent interpretation. Dr. Fletcher has not mentioned malingering but we have an excellent test for detecting malingerers as they come in. You have in your hand a little device for cutting it off, but the patient cannot see this.

I am not prepared to say that the audiometer will take the place of forks for differential diagnosis. I do not mean to abandon my forks until I have something

better, or until electric engineers can develop a bone conduction apparatus for this instrument. I would like to repeat what Dr. Goldstein said about appreciation. Birds come home to roost. Dr. Bell started out as a teacher of the deaf, then developed the telephone. Now the work is paying dividends.

DR. FOWLER: Dr. Fletcher's paper has covered the subject thoroughly. There are several points in Dr. Goldstein's paper that I would like to discuss. First, in regard to tone islands, I have examined hundreds of charts with the original audiometer which has 3 octaves, but I have not found tone islands. They may be accounted for by defects in the instruments. We may draw diagrams of obstructive deafness, and nerve deafness, but we do not know that they are correct. Usually the high tones are cut down in nerve deafness, and low tones in obstructive deafness, but there must be obstruction in the cochlea. We are interpreting this on the old level of argument, which is approximately true but there may be exceptions.

This is the general scheme on rapid examination: first, examinations show graph diagnosis at school. The next shows a different graph. It will daily keep going down, and eventually it will be pictured as otosclerosis. I think the most valuable factor about the audiometer method is that we can find out how the ear is degenerating and how the process is progressing. We shall be able to figure out the abnormal wave carried on several cases for several years, keeping track of the hearing lost for each frequency. It gives you a total loss and also all the year's progress of the case. That is an important point.

Tuning forks may be used for this purpose but we must calibrate the forks. I have calibrated forks for bone conduction and we start the tests at the level of minimal audibility. We cannot dispense with tuning forks. The audiometer is for clinics and hospitals, but in the office we can get careful, accurate measurements with the tuning fork. A nurse can test with the audiometer if she is trained to be accurate.

DR. FLETCHER: In regard to increasing the loudness of the tone, we do not wish to do that, or we would be liable for lawsuits. It might injure people, either with normal or abnormal ears. That is for Mr. Wegel to find out, how far we can go down without injuring the ear. Finally you reach the feeling point, when you do not know whether you are hearing or feeling. We have made an amplifier, but we try not to get beyond hearing. As to the question of the seven tones, you would not get a different shape of the curve if you had seven tones. Dr. Fowler and Mr. Wegel pointed out in the first paper, that you can make these tones continuous by a condenser if you need it, but you can use the audiometer without it. The cut out is for testing malingering. Some of the psychologists and physiologists use the instrument in research work. You can make the patient respond. You do not ask him when he hears. Either he is not hearing or he is not paying attention. You get a point very definitely. In regard to the bone conduction receiver, we do not claim much for this. It is in rather a critical state. In a year or two we shall know more about it. At present the tuning fork is better for differential diagnosis. This receiver does not work for high frequencies, but it will work below 1,000 cycles very well.

DR. GOLDSTEIN: I do not think we have thoroughly mastered the problem of the tuning fork versus the audiometer for bone conduction, but there is a difference between tuning fork bone conduction and the audiometer method. In the one case there is an inconstant limit; it dies down slowly. In the audiometer you can have time limit. It dies down when you like. If you have a conduction

deafness case you can say you have a welling up over the normal line. In regard to power, intensity is increased in the amount of sound you develop in a given case. I will assume 200 dynes for a totally deaf child, but if the child can hear a cannon shot I want to know it.

DR. FLETCHER: We have had a great deal of help from the otologists in designing instruments. We have had to sacrifice some of our own ideas in trying to meet the needs of the otologic profession in the planning of instruments.

DR. GOLDSTEIN: I should like to move that we offer a vote of thanks to the Western Electric Company for the scientific and intelligent cooperation which we have had from them.

(A rising vote of thanks was given by the Association.)

THE VESTIBULAR TESTS AS EMPLOYED BY THE ARMY (U. S.) AIR SERVICE. Presented by CAPT. C. A. PFEFFER, U. S. Army.

This paper describes the technic of the Bárány chair rotation test as well as caloric douche test of the vestibular apparatus. The qualifying limits of nystagmus rate, past-pointing and falling as prescribed by present army regulations and the proposed new regulations are discussed. Deviations from the commonly accepted normal reactions, in the pilot, are interpreted as a probable over compensation on the part of the pilot for the falling and pointing reactions frequently observed—particularly in many constant stunt fliers.

Flying is not an ear problem, although the danger of flying with abnormal vestibular function is not to be overlooked.

Due importance in the maintenance of equilibrium to orientation is given to vision and body sense, that is, tactile, muscle, joint and viscera.

The internal ear is one factor in flying. The most important factors in the selection of the flier are the eye and the nervous system. The ear is of secondary importance in the case of the flier, the nervous system being the most important. Once the pilot has learned to fly, the ear is of even less importance.

EXAMINATION OF AVIATORS WITH ORIENTATOR. Presented by W. G. RUGGLES,

Man is a native of terra firma. His love of travel and speed in his journeys are conspicuous. His efforts are ever toward greater velocity. A sculptor became immortal by putting wings on the ankles of Mercury. Folk lore and history set forth man's desire to fly with the birds in the clean, free domain of the air ocean, and in the vernacular common to localities we sense his irrepressible longing by the names bestowed on excessively mobile units of his transportation. We had the "Flying Squadron" of fast naval vessels; the "Dixie Flyer" railroad train; the "Thomas Flyer" automobile, etc. Each of those hurried but did not fly. Man now lives in an era of actual flight and wide attention has been given to examining and grading individuals to determine which could be successful in this new art. We, sadly, have learned some were not adept.

All through these years of the development of aviation, it has been my sincere belief that of greater importance than normal nerve-end organs is a cerebral ability to assimilate nerve information and coordinate and synchronize muscular activities suited to the positions or occasion. Irrespective of an individual's other accomplishments or wisdom, it is that ability which enables him to fly gracefully and guide his airplane consistently to smooth, soft landings.

The very extensive and painstaking work of the United States Air Service has shown that a great many student aviators who appear normal cannot become superlative pilots after 100 or more hours have been devoted to training them.

It was to diagnose those latent faculties and accomplish their primary education that I envolved my orientator. In no sense should it be operated violently to see if the student can "stand" the gyrations of the airplane. Extreme gentleness and accuracy of operation is advantageous and enables a diagnostician understanding it to estimate and improve a student's perception, cerebration, coordination, synchronism, and delicacy of muscular activity.

Subnormal sensory fields may be more than compensated for by abnormal capabilities of other units active in the composite which, together, make success.

By most rigorous trial at the Primary Flying School of the Air Service on a considerable number of men, the theory is found to be practical.

DISCUSSION

MAJOR BOWER (by invitation): I would like to emphasize the importance of the subject in aviation. In the war we supposed that the vestibular apparatus was very important; now we consider it a secondary consideration. In selecting the flier, we choose a man with good eyes, good nerve stability and also good reaction time. Nervous stability counts most. So far as the Bárány reactions are concerned, we know now that nystagmus, past-pointing, falling, all decrease in the average flier. We find we laid too much stress on the Bárány reactions. Test pilots never past-point after 100 hours of flying. We should need tests which would embrace change of motion from one plane to another, to bring out the reaction of the feeling of the seat or visceral feeling. In regard to the Ruggles orientator, that has possibilities in the selection of fliers and their training. One of the most important factors is the relation of reaction time.

DR. FISHER: The British examine fliers for vestibular mechanism only when there is vestibular disease. If it is only advisable when there is trouble, it shows the vestibular mechanism can give trouble in flying. Why not, therefore, examine everyone? You either need it or you do not. As to the vestibular mechanism in aviation, I do not think the philosophy of it was ever explained. I do not mean that examinations would prove whether a man would make a good or a poor flier, but we want a person as normal as possible in every respect, so that such an important mechanism as the vestibular may be normal. In such dangerous work as flying, the aviator should not be handicapped by any defective mechanism. The relation of the ear to equilibration is not perfectly understood. It has been claimed that the ear is the equilibratory organ of the body. That is not so. The brain sends out appropriate messages to the musculature, and is constantly informed of what is going on by various special senses, namely, the eyes, the touch, ears and visceral sense. The eyes help largely in equilibration, as its function is to form a clear perception of surroundings, and equilibration is secondary. Nature has constructed a mechanism so that no motion of variation of the body escapes perception, and the brain functions better if the ear aids in sensing motion and position, but the ear is not the equilibratory organ. It merely sends position messages to the brain. The flier says his eyes help him most, but that does not prove it, any more than a man can tell whether his stomach helps him most in digestion, it may be the ileum, jejunum or pancreas. The important point is that the nerve pathways from the ear are an important component part of the entire nervous system.

Our methods of examination were merely an attempt to determine whether the mechanism was functioning or not. An experienced flier may lose the function of past-pointing, but that does not mean damaged mechanism.

DR. PFEIFFER: Mr. Ruggles' paper has brought out the importance of the reactions of the nervous system. I believe that the men, after being in the

orientator for some time and becoming accustomed to the various motions, will respond better in the plane than otherwise. As to the function of the inner ear, I think the importance of it is to determine whether there is abnormality of the mechanism. We should understand the danger to the pilot of abnormal sensations, not only from the internal ear, but also from tactile, joint, skin, visceral and other sensations. The brain in correlating these sensations from the peripheral organs does one of the most important tasks for the flier. We do not minimize the internal ear; it is not the only function, but is supplemented by tactile, visual, joint and visceral impressions.

MR. RUGGLES: I think that all of what has been said is true, but one thing has not been mentioned. Most of our orientation sensing mechanism is more or less voluntary, but the labyrinth mechanism is involuntary. The nerve pathways from the labyrinth to the brain are very short. It seems to me that in such a field as flying, in which the seconds are split in very small fractions owing to enormous velocities, that correct information from the labyrinth to the brain is very important. If we get violent involuntary reactions, owing to antagonistic messages to the brain, the student will do things that he has no idea of, with the hands, the eyes and the feet; that is, he does things in the orientator that would kill him in the plane. The brain gets abnormal information caused by the abnormal twists and positions in which the student finds himself. After all, the most important help is the information that a man gets from his sensory fields. If this is not productive of the proper motor response, his work in the air is rough and a failure. If he can assimilate impulses and generate the right motor response, his work is superior.

MAJOR BOWER: What the pilot has to say has very little to do with it. A blind pilot with a good vestibular mechanism would be in a hopeless position. The vestibular mechanism is one part of the function of equilibrium, and equilibrium is part of the whole protective mechanism. That fliers should be normal in every respect is the important factor in aviation.

DR. RANDALL: After all, is it not the most important thing to know what the men will do with the information they get from sensory channels? Success depends on accurate information. Having had a little influence in bringing this matter into use in the army, I have felt great interest in its development. I suggested to the Surgeon General that it was better to test the men in the turning chair and such methods rather than to smash the machine and kill the man. At the time tests were begun, it was a fact that aviators were good for only about seventy hours in the air. If a man survived that time he had had enough unfortunate experiences to incapacitate him. I believe that the damaged limbs and broken planes fully justified our putting this matter before the Government, although the Bárány tests were poorly done, I hear, in many instances. I believe we did accomplish something. I understand that in the British aviation service the accidents were frequent and conspicuous, and that publication was withheld because the subject was too gruesome.